TENNESSEE VALLEY AUTHORITY
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HARTSVILLE NUCLEAR PLANTS

VOLUME 2

4.0 Environmental Effects of Site Preparation, Plant and Transmission Facilities Construction

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4.1 Site Preparation and Plant Construction

Construction of the proposed Hartsville Nuclear Plant is anticipated to begin in April 1975 with commercial operation of unit 1 scheduled for December 1980.

The optimum construction schedule (Figure 4.1-1) calls for start of fuel loading of the first unit 54 months after receipt of the construction permit and full start of onsite construction and a total construction period of about 8 years. Forecast employment levels of TVA employees (excludes contractors' workmen) over this period are as follows:

Months After Start	Employees
3	325
9	1150
15	1900
21	2450
27	3150
33	3900
39	4325
45	4525
51	4600
57	4125
63	3525
69	2400
75	1375
81	575
87	300
96	0

Initial construction work extending over approximately the first two years will include: (1) clearing and general grading of the plant site and construction plant areas; (2) erection of the "Construction Plant Facilities" including various shops, warehousing facilities, utilities, concrete mixing plant, administration buildings, roads, railroads, etc.;

and (3) completion of excavation of earth and rock and yard fill placement in the area of the main powerhouse complex and for other permanent features. Another principal phase of work will be the concreting program which will begin about 6 months after the initial construction activities. Equipment installation will follow concreting operations and extend over much of the remaining 8-year construction period. Near the end of plant construction, all temporary construction facilities will be removed and all surplus material and equipment will be disposed of, either through shipments to other TVA projects or by sale. The total construction area will be well landscaped.

Construction activities at the site will be planned to minimize undesirable effects such as land erosion, siltation and turbidity in the reservoir, accumulation of scrap materials, and burning of cleared brush and trash. Temporary construction buildings and storage and parking areas will be arranged in a neat and orderly manner, along existing roads and in previously cleared areas where possible, to minimize clearing and land use requirements, to expedite construction operations, and to facilitate routine groundskeeping and housekeeping.

4.1.1 Land Uses Affected - Construction of Hartsville Nuclear Plant permanent features will require about 350 acres of the 1940-acre plant site and about 75 acres additional for the access railroad. Another 350-400 acres of land will be disturbed for temporary construction facilities and borrow areas. For the most part, by the end of the construction period the latter areas will have been regraded and revegetated or allowed to return to their natural condition.

<u>General Clearing</u> - The land, particularly the areas where construction plants and the powerhouse complex are located, has been generally cleared by previous owners and is very sparsely wooded. The powerhouse complex, including the switchyard and natural draft cooling towers, takes in an area of approximately 300 acres containing only a few trees and underbrush. (Details of clearing by features are not yet available.)

The construction plant areas, which will total about 300 acres when developed, are tentatively located in mostly previously cleared areas. Additional clearing requirements will be coordinated with the TVA Architectural Design Branch and the Division of Forestry, Fisheries and Wildlife Development to minimize clearing and to provide screening of the construction areas from public roads. Such coordination assures that as much vegetation as practical is left within the construction plant areas for aesthetic value and to reduce adverse effects. Most of the existing wooded areas on the site will remain undisturbed.

Because of the general cleared condition of the site, it is anticipated that a total area equivalent to about 25 acres may be affected by tree cutting and clearing required for the construction area needs. Merchantable timber, if any, will be offered for sale if feasible. No significant impact on local forest resources will be caused by clearing on the plant site.

<u>General Grading and Excavation</u> - Preliminary design information indicates the following grading and excavation quantities will be required for onsite construction of the Hartsville Nuclear Plant.

	Cut (yd^3)	Fill (yd^3)	Dredge (yd^3)
Plant area grading	2,000,000	3,000,000	--
East dike (yard drainage)	--	100,000	--
West dike (yard drainage)	--	500,000	--
Intake channel	330,000	12,000	5,000
Discharge pond	--	180,000	--
Access railroad	*	*	--
Construction plants	1,657,000	1,657,000	35,000
Totals	3,987,000	5,449,000	40,000

*See "Construction Plant Facilities" (page 4.1-6).

Following clearing and removal of stumps, topsoil will be removed, stored, and seeded as necessary for future use. The initial grading will consist of preparing some of the construction plant areas and to start grading for the main powerhouse complex and cooling tower area down to designed plant grade.

As the excavation of the powerhouse complex continues, earth will be removed by large rubber-tired panscraper units to horizontal and vertical excavation limits conforming to design drawings. The yard drainage ponds will be constructed during this phase. Suitable backfill material will be stored if necessary for future use and spoil material unsuitable for any use will be wasted in depressed and/or coordinated preselected areas where it will be graded to conform with the surrounding landscape, covered with topsoil, and seeded and mulched to avoid erosion. Some 1,500,000 yards of earth material must be obtained from borrow areas to provide the total fill material needed (see tabulation above). On completion of the borrow operations the borrow areas will

be graded to blend with surrounding area contours and restored to a natural condition by seeding and mulching.

Following the above, excavation will proceed for the intake channel and pumping station. The major portion of the intake channel will be excavated in the dry. Following completion of the channel, pumping station, and other work behind the dike the channel will be flooded by pumping from the reservoir. The dike will be removed by panscrapers, draglines and/or clamshells, and by suction dredging if feasible.

Following removal of the dike, the corrugated metal pipes will be constructed on dry land, floated into place, and sunk. A dike to separate the channel from the reservoir will be constructed above the pipes. An anchorage system will be installed to hold the pipes in place.

On completion of the removal of earth overburden in a given area foundation rock will be excavated by the presplit method along excavation outlines as required for the structure foundations. The rock will be broken up by small blasting charges and removed by use of power shovels and trucks. Final details of blasting will be developed as additional foundation data are obtained and actual rock conditions are known.

The general methods used for protection against soil erosion and resultant siltation are those standardized construction practices that have been used successfully over the years. However, as new techniques are developed which would give a better balance of reduction of environmental impacts and cost, TVA will use these techniques wherever feasible.

<u>Construction Plant Facilities</u> - Concurrent with the above grading and excavation program will be the building of construction plant facilities including the administration building; field offices; craft shops; concrete mixing plant; warehouses and storage yards; raw and treated water systems for equipment cooling, drinking water, concrete mixing, etc.; service air systems; construction barge slip ; substation and electrical distribution; sewage collection and treatment systems; roadways; railroads; etc. Timing for this work will be to complete those facilities required for permanent concreting operations about 6 months after initial onsite work and to essentially complete all temporary facilities within the first 2 years. The location and layout of the temporary facilities are tentatively designated in 14 areas, A through N, for potential development as shown in Figure 4.1-2. The areas contain a total area of 343 acres; from experience at our other nuclear plant construction sites we will probably develop a total of 250-300 acres. The areas and estimated excavation quantities are tabulated below.

Area	Possible Use	Excavation Cut-yd^3	Excavation Fill-yd^3	Area Acres
A	Warehouse, yard storage	60,000	120,000	32
B	Shops, lumber storage	85,000	25,000	30
C	Parking	25,000	25,000	9
D	Parking	12,000	12,000	4
E	Warehouse, rail storage	600,000	600,000	77
F	Access corridor	90,000	--	17
G	Shops, resteel yard	240,000	330,000	42
H	Parking	--	--	7
I	Shops, lumber storage	300,000	300,000	26
J	Warehouse, yard storage	100,000	100,000	58
K	Parking	20,000	20,000	8
L	Parking	60,000	60,000	18
M	Concrete plant	50,000	50,000	10
N	Administrative offices	15,000	15,000	5
	Totals	1,657,000	1,657,000	343

The following paragraphs discuss some of the more important of these facilities from an environmental effects standpoint.

There will likely be two access roads to the site during most of the construction program. Traffic will enter the project area via these roads which extend from State route 25 highway passing along the northern boundary of the site. Existing roads within the site area will be used as much as possible for construction. Except for the permanent plant access road, there are no plans for new road construction or general upgrading of existing roads outside the reservation boundary area; however, some repairs and modifications may be required due to abnormal use during the construction program. Actions will be determined on an individual basis in concert with local highway officials at an appropriate time. At peak of activity it is estimated that TVA and contractors' employees will approach 5,000 in number and will drive about 2,000 vehicles to work. Although most of the heavier items of permanent equipment will arrive by rail or barge shipment, numerous equipment deliveries by motor freight are also anticipated via State route 25. Concrete aggregates, cement, etc., will require many shipments, and quite likely these also will be by truck.

The proposed access railroad to the site shown on Figure 10.12-1 will consist of a 5.7-mile-long spur from the Louisville & Nashville Railroad Company line at Hartsville, Tennessee. As proposed, the route would start in downtown Hartsville at the end of an existing spur and would dislocate two dwellings and pass through the back portions of several large residential lots presently abutting an industrial area. It would then cross near an open field used for recreation purposes and pass near additional residences before entering the open, undeveloped area southeast of Hartsville. This undeveloped area is characteristic of the land

use along the remainder of the alignment. Preliminary estimates indicate that about 75 acres of land will be disturbed for construction of the railroad bed and another 60 acres may be needed for borrow areas. Rough excavation quantities amount to about 415,000 yd^3 of cut which will be reused as fill and about 963,000 yd^3 of borrow. Railroad construction will occur early in the construction program either by TVA forces or contract, or a combination of these. The primary environmental considerations during the construction phase will be disposal of solid wastes from right of way clearing and erosion of exposed slopes and borrow areas. If clearing is performed by a contractor, disposal of wastes will be his responsibility including obtaining any permits needed from state and local agencies. Generally, the approach used for plant site clearing will be employed for waste disposal. Limiting of gradient and rolling and seeding of slopes soon after they are established will be among the measures used to control erosion. Final designs will specify other methods, devices, and drainage structures to protect the slopes from erosion.

The envisioned construction railroad storage yard will be developed primarily in about a 75-acre previously cleared area and will contain about 5 miles of track. About 600,000 yd^3 of earthwork will be required to smooth the area. The area will be surfaced with broken rock or crushed stone as required to support lifting and hauling equipment. Some erosion can be expected, particularly during excavation, and runoff will probably increase due to surfacing. The area will drain toward the river; however, its downhill limits will be several hundred feet from the river bank providing a buffer which will intercept most of the suspended material before it reaches the river.

The concrete mixing plant and aggregate storage facilities will be developed on a previously cleared, 10-acre area adjacent to and north of plant A site. Because of the topography of this area only about

50,000 yd^3 of grading is contemplated. These facilities will be needed early since concreting is to begin about 6 months into the construction program so some grading of the area and excavation for mixing plant footings will be among the first construction activity. Some minor erosion will be unavoidable during this time. Waste water from aggregate rinsing and washing down of concrete mixing and hauling equipment will likely be routed to the yard drainage pond east of plant A. Due to the distance over which it must flow, most of the suspended material will settle out before reaching the pond. If the cooling tower contract includes furnishing of concrete, the specification will require that the contractor provide waste water treatment and disposal facilities meeting requirements of the State and other authorities and that proper permits be obtained.

The construction raw water system pumps will be mounted on two circular, sheet-pile cells driven in the vicinity of the barge slip. Two electric-driven, 1,000-gpm pumps will be mounted on the cell for each plant and a 500-gpm diesel-driven pump will be provided for emergency operations. One or more storage tanks will be provided. Underground lines will serve the storage tanks, shop areas, powerhouse, and other areas for fire protection or where raw water is needed for other uses. These lines will be placed in ditches with other service lines where possible. Some erosion may be expected from excavation of ditches and some increased turbidity will occur when the cells are being driven and minor dredging is taking place to provide adequate depth below minimum pool at the pump intakes. These adverse effects are expected to be minor and of short duration.

There will be two main storm water collection systems available during the construction phase; one will discharge into the yard drainage pond east of the powerhouse and the other into the pond to the west. Construction drainage ditches and pipe systems will be designed to flow into these ponds where possible so storm water will undergo a period of settlement before being released to the river. Areas around buildings and parking areas will be covered with crushed stone and sloped to drain into the collection system. Check dams, diversion dikes, sediment basins, and other control devices as required will be used in conjunction with seeding and mulching to provide additional runoff control. Buffer zones of 20 feet or more will be left along flowing streams and drains to retard rate of flow of storm water.

A barge slip 50 by 150 feet will be constructed on the shoreline between the upstream tip of Dixon Island and the intake channel for offloading very heavy components and to handle other barge traffic for the project. Essentially, the slip will consist of a row of sheet-pile cells angled into the flood plain and a headwall across the inland end to retain the adjacent earth fill. The bottom of the slip will be surfaced with crushed stone to allow barges to rest evenly to unload the heavy components. This facility will be constructed mostly in the dry to minimize erosion after which the slip area will be flooded and the dike at the river end will be removed. Slopes will be protected by riprapping. It will be necessary to dredge some 35,000 yd^3 of material for a channel from the slip to the main river channel. Dredge spoil will be discharged on a selected dry land area in a manner which will allow settling out of suspended material. Increased turbidity may be expected

during the dredging operation and dike removal; however, this should extend over a period of a few weeks at most. Afterwards some turbidity might result briefly from disturbing of silt when barges are being handled in the area. The barge facility should not affect streamflow by Dixon Island or have any significant impact on recreational use of the reservoir. The slip may remain in place as a part of the permanent plant facilities in which case only occasional use would be expected.

Solid Waste Disposal - Trees which must be removed that have no commercial value and stumps will be cut, piled, and burned as the circumstance dictates. All burning will be performed in compliance with applicable Federal, state, and local air quality regulations. There will be no burning of solid waste containing garbage. Metal, lumber scrap, and other salvageable material will be collected and offered for periodic sale and removal from the site. Broken concrete, rock, and residue from burning will be used as unclassified fill material onsite. Other solid wastes will likely be collected and disposed of by a private contractor in a state-approved sanitary landfill. A sanitary landfill will be developed onsite only if such facilities or disposal services are not otherwise available.

4.1.1.1 Human Use Affected - Adequate control will be maintained over noise, dust and erosion arising from site preparation so that no effects will be experienced offsite to significantly affect the present and expected human activities on land and water near and adjacent to the site. However, the railroad will have an impact on a residential area in Hartsville. This effect is small because of the existing industrial use nearby already influencing the character of the area. Other aspects of human uses which might be affected, such as traffic, school enrollments, dislocations, etc., are discussed in Section 4.2, Socioeconomic Impacts.

4.1.1.2 Effects of Construction on Terrestrial Environs - Construction effects due to development of the Hartsville Nuclear Plant will occur in two general categories: (1) onsite habitat losses and (2) offsite habitat losses and alterations.

Both adverse and beneficial effects will result. Adverse effects on terrestrial environs are expected to be minimal due to the low diversity of existing habitats, considerations to be utilized during the construction phase to minimize effects and considerations included in the selection, design, and location of plant subsystems. Beneficial effects on the terrestrial environs will be initiated during the construction phase with the cessation of agricultural use and the resulting development of more diverse habitats.

Onsite effects will result in loss of approximately 350 acres of habitat due to construction of permanent plant facilities and borrow areas and the alteration of an additional 350-400 acres for construction facilities. The remainder of the site will not be directly affected by construction activities.

The wooded corridors along Dixon Creek, Cumberland River, and Dixon Island will not be occupied by temporary or permanent facilities. For instance, the intake, discharge, and barge port have been located to avoid these wooded habitats.

Clearing will involve an area equivalent to about 25 acres of wooded habitat on the lower slopes of the wooded knoll north and east of the plant. This clearing of scattered patches, stringers, and fringes will not result in significant vegetation losses.

The area occupied by temporary construction facilities is short term. Subsequent removal of these facilities and revegetation represents

a habitat modification and, in the long run, creation of more stable and diverse habitats.

Cessation of agricultural operations on portions of the site not directly affected by construction activities is viewed as beneficial from a terrestrial habitat standpoint. Changes expected include gradual shifts to natural upland habitat on lands now used for pasture and crops, an expansion of the wooded corridor along Dixon Creek and the Cumberland River and further development of cedar-hardwoods type on the knolls to the north and east of the plant.

In addition to these effects, construction activities will result in increased noise levels, dust, silt deposition, human activity, and the potential for accidental spills of fuels, oil, and chemicals is increased. As indicated in other portions of Section 4, extensive efforts will be initiated to assure minimal effects during construction.

Offsite effects will result from development of rail access, borrow areas, transmission facilities, and the influx of construction personnel (Sections 4.1, 4.2, and 4.3).

Development of rail access will result in a loss of approximately 75 acres of habitat. The large majority of the proposed right of way is used for agriculture. Rail access will involve crossings over Goose Creek and Corley Branch. These crossings will result in minor effects due to the removal of small areas of woodland habitat. These effects are not considered significant.

Borrow areas will be required for material used in plant development. Specific sites have not been identified, but the considerations indicated in other portions of this section are intended to minimize adverse effects on terrestrial environrons.

The influx of construction personnel is expected to result in some land use shifts, primarily to provide for housing. These effects will result in an unquantified reduction of terrestrial habitat. A program to ascertain these effects is in section 6. It is anticipated that a majority of these land use shifts will occur adjacent to existing communities and in areas now used for agricultural purposes. The effect is not expected to be significant.

4.1.1.3 Agricultural Use - Construction of the nuclear plant and related facilities will result in approximately 350 acres of the 1,940-acre purchase area being disturbed and lost to agricultural use, at least during the 40-year project life. This involves acreage actually occupied by the following plant facilities: concrete plant, shops, administrative offices, warehouses, storage yards, access corridors, and parking lots (see Figure 4.1-2). In addition, the remainder of the site within the purchase area would presumably be removed from agricultural use for the 40-year project life. Purchase of land for the plant, therefore, will remove from agricultural use about 1,750 acres (excludes woodland) which was occupied by pasture, hay, and row crops as of December 1973. The acreages of various classes of agricultural land removed from production are discussed in Section 2.2.

Removal of vegetative cover and land grading and cut and fill operations during construction will result in some erosion of soil materials. Care will be taken to minimize these erosion losses as much as possible by such practices as construction of diversion dikes, check dams, and sediment basins, utilization of mulches, and prompt establishment of grass sods on land which has been disturbed. Topsoil removed during initial land disturbance will be stored for use during final landscaping. Recommended fertilizer, liming, land preparation, and seeding practices will be followed for establishment of erosion-controlling sod covers after

A discussion of the existing vegetation at the Hartsville site is given in Section 2.7 and Appendix F3.

4.1.2 Water Uses Affected

4.1.2.1 Human Uses

Erosion and Siltation - The amount of soil displaced by erosion due to construction activities, including dredging, is estimated to average about 1,500 tons annually for about a 6-year period. A portion of this amount will be retained in the yard drainage ponds and to buffer zones and will not enter flowing streams in the area.

General grading for the construction plant areas and the permanent plant area will follow grading plans developed by design and construction engineering personnel. Following clearing and grubbing, usable topsoil will be removed, stored, and rolled and seeded as necessary for future use in final landscaping work. The topsoil will be stored and rolled to minimize loss due to erosion. Grading plans will show roadways, drainage ditches, catch basins, and specify sloping of cut and fill areas to drain. The grading operations are conducted to provide and maintain a controlled surface drainage system to minimize erosion and resultant silting of the reservoir. Certain erosion control measures used in conjunction with a master grading plan include limiting of gradients and the use of berms, diversion dikes, check dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, special drains, and other control devices.

Since TVA performs most of its own work with force account labor, it seldom becomes involved with contractors' efforts to adequately control erosion. This provides better control over construction operations

which could result in adverse environmental impacts. The cooling towers and possible other features will be contracted and TVA will enforce erosion control considerations which will be included as a part of the contract requirements. Inspectors and engineers working for the project management organization control the extent of erodible material uncovered and direct the implementation of erosion control measures and devices as deemed necessary to protect adjacent streams. They will insure that erosion control practices are reasonably current with the excavation, borrow, and grading operations. The total project lies within relatively tight confines that should allow good current control by inspectors and engineers.

Some excavated material will likely be stored in sloped mounds, rolled to avoid saturation and erosion, and seeded as appropriate to permit its later use as fill. Temporary sumps will be provided in the powerhouse area for the diversion and control of runoff inside the excavated area. Water will be pumped to the yard construction drainage system and further treatment, such as settling pond use, will be effected if required to avoid excessive siltation of the reservoir.

Gravel will be used in the construction areas to provide cover for parking, storage, and work areas. Heavy rock bases are laid for construction roadways to avoid rutting and erosion from the use of heavy equipment. Buffer zones will be left along streams and drains. Side ditches are cleaned out as needed for proper drainage and side slopes are protected where deemed feasible by seeding and mulching or matting.

Present indications are that the excavation of the intake channel to the raw water pumping station, the barge slip, and the blowdown system diffuser are the only plant features where possible dredge or dragline operation along the

waterfront would have an undesirable effect on the quality of the water in the reservoir. As previously described, excavation of a major portion of the channel will be conducted behind a dike which must eventually be removed by dredge or dragline. Although construction methods are unknown at this time appropriate siltation control methods will be utilized during construction of the blowdown diffuser. Special efforts will be made to minimize silting in the reservoir. However, a certain amount of turbidity and siltation is an unavoidable consequence of operations such as this, and fine control is very difficult to accomplish.

Sanitary Wastes - Temporary sewage treatment plants capable of handling the peak construction force sewage loads will be installed. Separate sewage collection systems and treatment plants will be provided for Plant A and Plant B to serve the respective shop, office, and storage areas. Each treatment plant will probably consist of 3-package units, aerobic digestion-type, with a maximum capacity of 12,000 gallons per day each. The effluent from these plants will be treated and discharged into a detention basin or directly into the river. Appropriate NPDES permits will be obtained and their terms will be complied with as necessary.

In addition, chemical toilets will be used in isolated or remote areas during the construction period, and the servicing contractor will as a contract condition be required to dispose of raw sewage in an acceptable manner. Generally, these wastes are collected in contractor-owned tank trucks and are hauled to a local state-approved community sewage treatment plant for disposal.

Chemical Wastes - Chemical cleaning operations prior to unit startup will be conducted to minimize releases to the reservoir and to ensure that any chemical wastes released have been neutralized and diluted

to concentrations which are acceptable for discharge into the reservoir. To minimize the potential impact of these wastes, every effort will be made to attain a high level of cleanliness from the outset. TVA will purchase "clean" pipe and will maintain a high level of cleanliness during erection of piping. Once erection is complete and if no rust is present the piping may be flushed with clean water. However, if rust is still présent after instituting the above cleanliness measures, a wetting agent such as Na_3PO_4 may be added to the flushing water to aid in the removal of rust and other contaminants. In any case, waste water or waste solutions from cleaning operations will be directed to a pit for storage and treatment. Typical treatments prior to release of effluent to the environs might include filtration to remove suspended solids and addition of lime to precipitate the phosphate wetting agent.

Standard design and construction procedures will be utilized in construction of holding ponds. All vegetation and unconsolidated material will be removed from the dike foundations and the dikes will be constructed with clean impervious soil placed in layers and compacted with earth-hauling equipment. All pond areas will be stripped of vegetation and other undesirable materials.

Flushing Oils - Oils used during the cleaning process for transformer insulating oil systems and turbogenerator lube oil systems will be reconditioned for reuse or will be disposed of at some suitable offsite location.

Other - The barge slip to handle barge traffic into and out of the plant will be constructed with steel pilings to permit its use throughout the lifetime of the plant if desirable. Only minor interference with recreational and navigational activities is anticipated and this only when barges are maneuvering for docking. After the plant is constructed the dock would be used only intermittently, and no significant adverse impact on the use of waterways would be expected to occur.

Excavation activities during construction may temporarily affect ground water movement in the immediate vicinity of the excavations, but the ground water movement should return to near normal after construction is completed. No public or private use of ground water is expected to be affected due to construction of the plant.

Definite arrangements have not been developed at this stage for the potable water supply for construction plant and permanent plant needs. Present plans are to contract with the town of Hartsville to supply this need. Construction requirements could vary up to a peak use of 2,700,000 gal/mo during startup periods for the plant where high water usage is required in the plant flushing and cleanup cycles.

Raw water for construction needs in fire protection, equipment cooling, and other services will be pumped from the reservoir using two temporary pumping stations located at the waters edge near the plant site. This facility will have little effect on water quality or on flows in the vicinity of Dixon Island.

Waste waters generated on site will be treated so as to conform with the acceptable standards before discharge into existing streams or elsewhere.

Site preparation and construction should have little significant impact on the use of the Cumberland River for recreation. Pleasure and fishing boat traffic along this segment of the Cumberland should increase notably in the near future as a result of the recent formation of Cordell Hull Lake. However, since only minor, intermittent interference with navigational activities is anticipated, there should be a minimal impact on water recreation by site preparation and construction.

With TVA's extensive efforts to avoid and control erosion and siltation during construction, no significant adverse effects on river fishing should occur at or below the site.

4.1.2.2 Construction Effects Upon Fish and Waterfowl - Construction activities will result in two effects on fish populations: (1) alteration of existing habitats and (2) short-term increases in turbidity and sediment load.

Alteration of habitat will result from construction of the barge slip, intake and discharge facilities. These facilities have been located to avoid impacts on the shallow areas near Dixon Island and in Dixon Creek embayment. Consequently, effects should not be significant.

Short-term increases in turbidity and sediment load will occur during initial clearing and grading of the plant site and construction of plant facilities, rail access, barge slip, intake and discharge structures. Various procedures indicated in other parts of this section will be used during these construction activities to minimize the magnitude and duration of these effects. Fish generally avoid areas of

high turbidity but return when turbidity levels drop. Sediment interference with spawning activities should be negligible since shallow areas will probably not be impacted. Construction effects, therefore, are not expected to be significant.

The important aspects of the site for waterfowl are the riparian woodland corridors along Dixon Creek, Dixon Island and its adjacent shoreline and the Corley Branch embayment. In terms of breeding waterfowl, two species use this habitat type at the plant site. Wood ducks use is estimated to be moderate while use by resident giant Canada geese appears to be increasing.

Construction of the intake, discharge, barge slip, construction raw water intake, road access, rail access, and transmission lines are the primary potential sources of impact on waterfowl. These facilities have been located so as to assure minimal impacts. The rail access corridor is relatively fixed by existing terrain and will result in minor alteration of habitat on Corley Branch and Goose Creek. This effect is not considered to be significant.

A secondary effect is the gradual change of upland feeding opportunities on agricultural lands as onsite farming practices cease. This effect, while adverse to waterfowl, benefits other species which use early successional stages and is expected to be minimal. There is an abundance of agricultural lands nearby and probably portions of the existing open areas will be maintained as a part of routine operation of plant facilities and grounds.

4.1.2.3 Other Biota - Some aquatic fauna in the lower portion of Dixon Creek and in the Cumberland River will be affected by the plant construction. The greatest effect on fauna of Dixon Creek will result from excavations for installation of the cooling water intake system. Damage to benthic fauna should be minor as a result of constructing the proposed docking facility and the railroad access. Data from a preliminary limnological survey show the area to have sparse benthic faunal populations (see Section 2.7 and Appendix F2).

4.1.3 Miscellaneous Effects - In addition to those considerations already discussed, the following miscellaneous effects have been identified.

4.1.3.1 Dust and Smoke - To minimize the creation and effect of dust during construction sprinkler trucks will be employed on the construction roads and drives. Dust created in the concrete mixing plant operations will be controlled by use of filtering equipment and sprinklers if required. Smoke will be created mostly from burning of stumps, brush, small trees and other debris from clearing operations. Due to the relatively small amount of timber to be cleared smoke is expected to have only a minor impact mostly during the early stages of construction. Any burning will be controlled to minimize smoke and will take place under favorable atmospheric conditions and in accordance with local, state, and Federal guidelines.

4.1.3.2 Noise - Noise during the construction program will originate mostly from blasting and operation of heavy construction equipment. Some disturbance from blasting will occur mostly during

daylight hours and will be monitored and controlled if necessary so as to minimize disturbance to nearby residents and structures. Construction noise should have little effect on residents living near the plant site. Most of the noise will originate in the area of the powerhouse complex which is about three-fourths mile from private property. Also, existing trees and terrain should help to suppress the noise. Some noise may be expected from truck and rail traffic visiting the site mostly during the daytime. Mufflers for construction equipment will be maintained at least to the level of those furnished with the equipment when purchased. New equipment will be purchased meeting applicable Federal noise standards as such standards become effective.

4.1.3.3 Historical - Plant construction will have no direct effect upon any National Register Property or any properties in the area which may be deemed eligible for the National Register except for increased traffic and noise during construction. The historical significance of the Hartsville site is discussed in Section 2.3.

4.1.3.4 Archaeology - The Cumberland River valley, in comparison with the Tennessee River valley, has received little professional archaeological investigation. A comprehensive program of archaeological investigations is under way to ensure that adequate archaeological samples from the project area, together with access and transmission line routes, are removed and recorded; that appropriate salvage excavations are performed on significant interpretive archaeological sites; and that these results are published for a better understanding of the prehistory of the area. All archaeological sites directly affected or endangered by the plant construction activities or the presence of the

plant facilities will receive necessary investigation as determined by TVA in consultation with the professional principal investigator and/or the TVA Board of Archaeological Consultants. Investigations and salvage operations will be based on priorities established in accordance with the construction schedule.

Impoundment of Old Hickory Reservoir in 1954 inundated areas along the banks of the Cumberland River and especially along the flood plains in Dixon Creek and Lick Creek, making these areas unavailable for archaeological investigation.

Motlow State Community College, Tullahoma, Tennessee, is the contracting investigative institution for the project archaeological program. Mr. Steven Fox, Instructor of Anthropology, is the principal investigator for the project. All major construction schemes (access highway, access railroad, power transmission lines, intake water systems, plant layout, and heat dissipation systems) are being carefully evaluated against known and suspected archaeological sites to ensure the most efficient and effective program in investigatory archaeology is utilized. Motlow State is being provided with technical assistance in engineering, surveying, mapping, soil tests, and other available scientific services. In the early summer of 1974, plans are to conduct an experiment in remote sensing of archaeological sites. If certain features on significant archaeological sites can be located and interpreted before excavation of the site begins, this would aid significantly in the interpretation and excavation of the site, even though not necessarily reducing the cost of salvage archaeology.

The preliminary archaeological surveys of the Hartsville site conducted in August 1972 located numerous areas of prehistoric

habitation as indicated on Figure G-1. The full impact on archaeological resources by the construction of the proposed Hartsville generating plant is not completely known because of the lack of a complete and comprehensive survey. Archaeological surveys of the site are continuing in order to determine the significance of the identified sites.

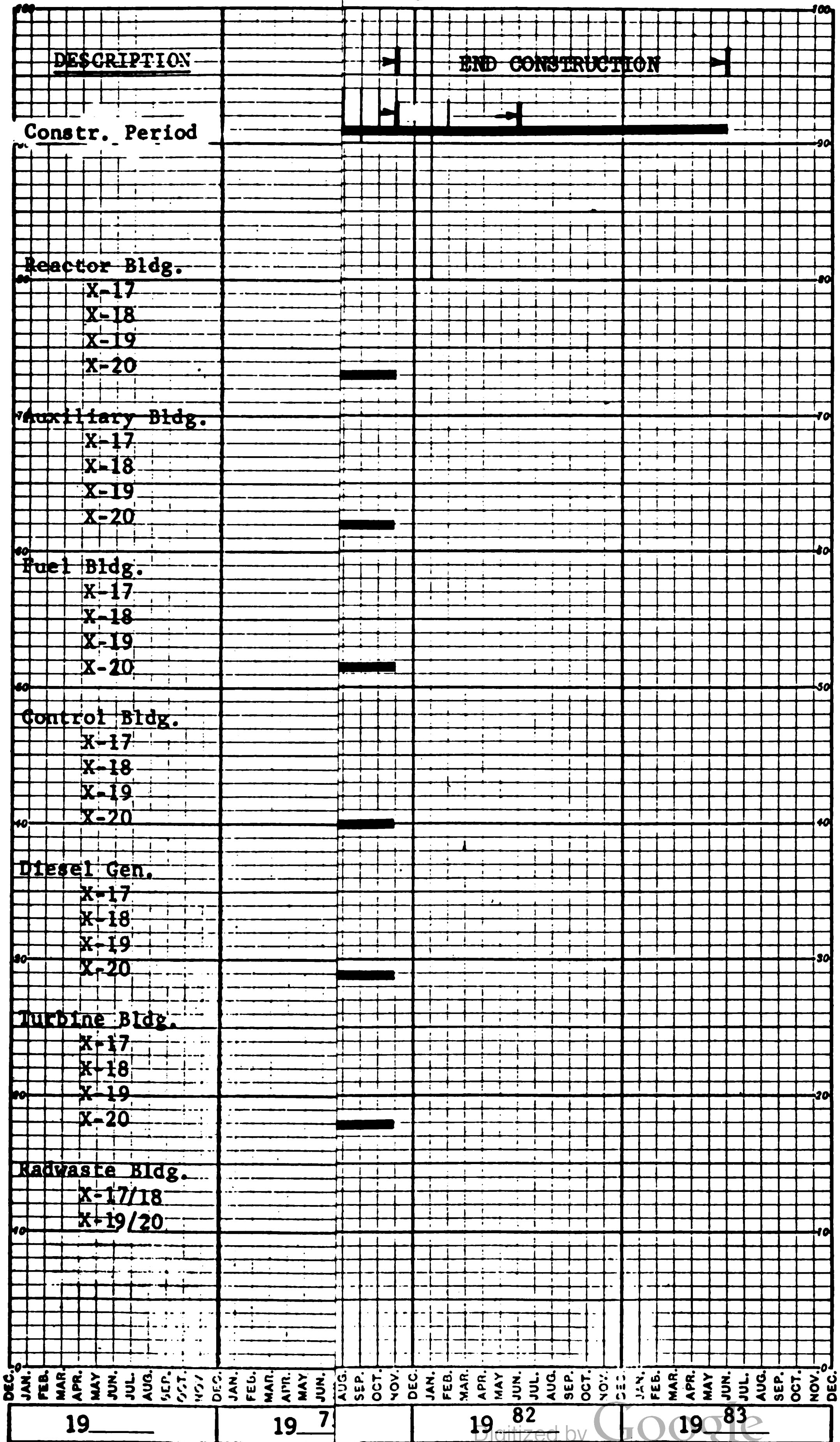
The construction of the plant intake may affect two known potentially significant archaeological sites. Site 40-SM-55 (see Figure G-1) appears to be a large Late Archaic site, dating 2,000 to 1,000 B.C. This site has a high priority for testing because investigation has indicated the possibility of an undisturbed midden deposit below the plow zone. Site 40-TS-3 may be an Early Archaic site (7,000-5,000 B.C.) and will be further investigated to determine its significance. Other potentially valuable sites which may be directly affected by plant construction will be further investigated prior to commencement of full plant construction to determine if any are significant.

4.1.3.5 Cemeteries - There are two cemeteries which may be affected by the construction of the Hartsville Nuclear Plant. A small portion of Wright Cemetery which contains approximately 61 graves is inside the exclusion radius. The other cemetery affected contains only one grave, and it requires relocation because of project construction. The grave is that of the Reverend John McGee. The grave of Reverend McGee is discussed in Section 2.3.

In order to facilitate plant construction, TVA would relocate these two cemeteries in accordance with a long-standing and well-accepted cemetery relocation policy. Relocation would be done with

the consent of surviving relatives and in accordance with state and county health regulations and under the guidance of the appropriate Federal court. The cemeteries will be placed in comparable or superior locations and conditions when relocated.

Figure 4.1-1


DESCRIPTION
END CONSTRUCTION
Constr. Period
Reactor Bldg.
X-17
X-18
X-19
X-20
Auxiliary Bldg.
X-17
X-18
X-19
X-20
Fuel Bldg.
X-17
X-18
X-19
X-20
Control Bldg.
X-17
X-18
X-19
X-20
Diesel Gen.
X-17
X-18
X-19
X-20
Turbine Bldg.
X-17
X-18
X-19
X-20
Radwaste Bldg.
X-17/18
X-19/20
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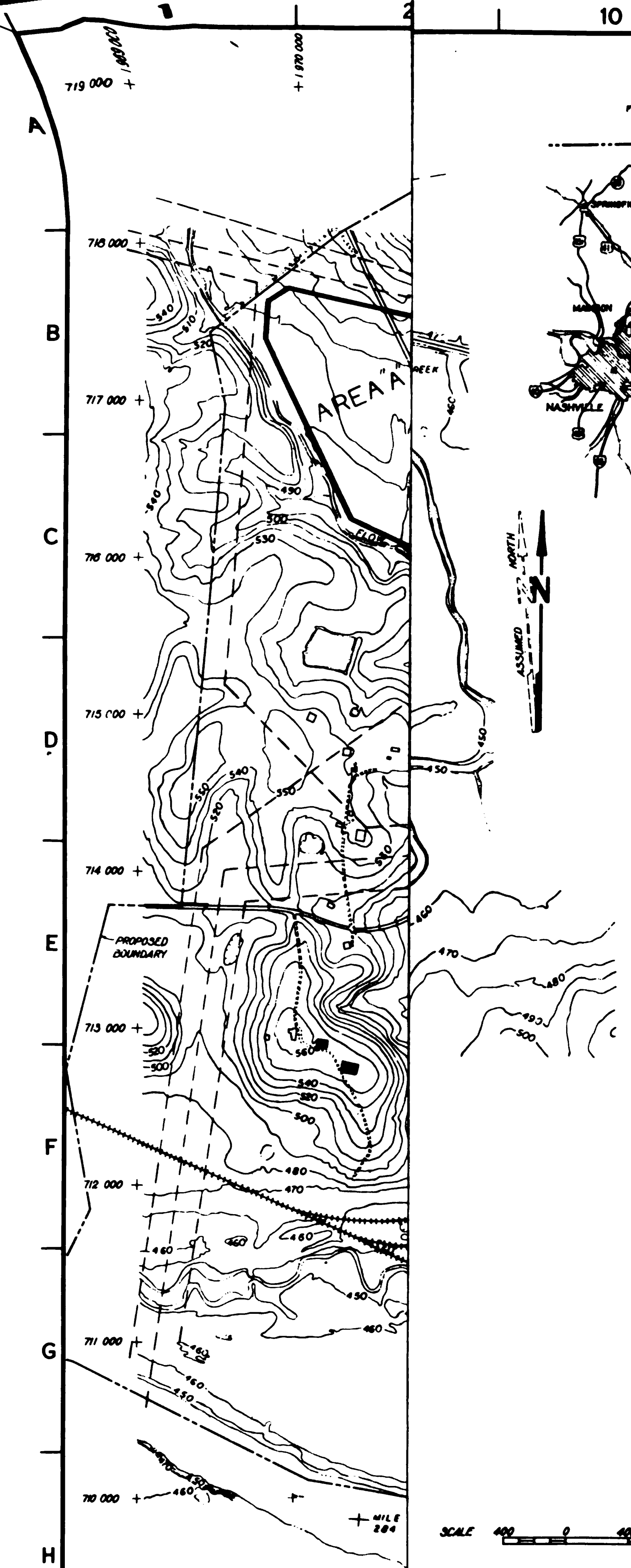
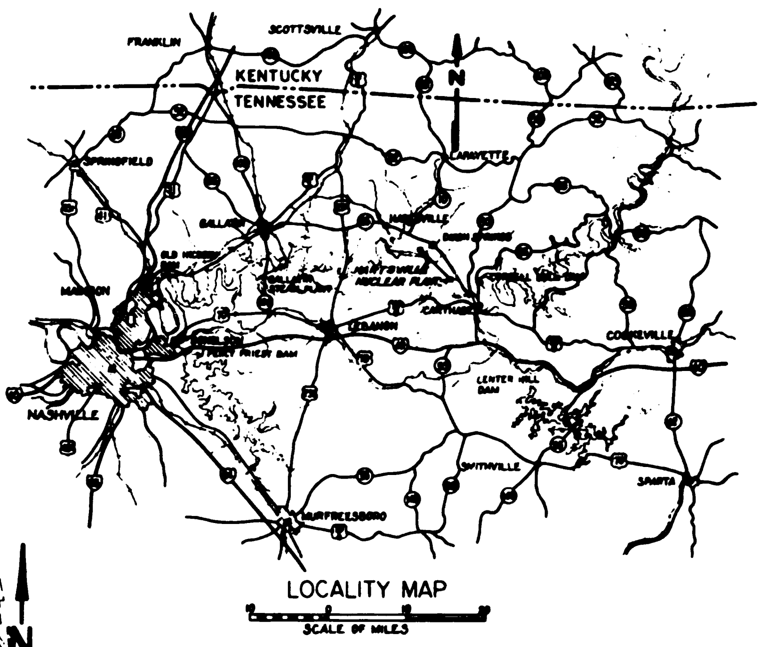
19 82
19 83





1. TOPOGRAPHY TAKEN FROM KELSH TWO FEET CONTOUR TOPOGRAPHY DATED 1973, AND REDUCED. CONTOUR INTERVAL SHOWN IS 10 FEET, EXCEPT AS NOTED.
2. FOR CLARITY, BUILDINGS HAVE BEEN IDENTIFIED ONLY ONCE FOR BOTH PLANTS A & B. THE BUILDINGS AND BUILDING LAYOUT FOR BOTH PLANTS ARE IN MOST PART, IDENTICAL WITH PLANT B ROTATED 180° WITH RESPECT TO PLANT A. THE OTHER BUILDINGS ARE OPPOSITE HAND (SECURITY, OFFICE, SERVICE, ETC.)
3. TENNESSEE LAMBERT COORDINATES ARE INDICATED IN THE MARGIN.
4. THE TENNESSEE LAMBERT COORDINATES FOR THE INTERSECTION OF THE N-S AND E-W BASE LINES ARE: X-1,975,420.30 AND Y-714,156.87.

SCALE 400 0 400 800 FEET

Figure 4.1-2

CONSTRUCTION PLANT
PLANS & LAYOUTS

PRELIMINARY
CONSTRUCTION AREAS

HARTSVILLE NUCLEAR PLANT
TENNESSEE VALLEY AUTHORITY
DIVISION OF CONSTRUCTION

SUBMITTED	RECOMMENDED	APPROVED
J.L. Henson	T.A. Bowles	[illegible]

KNOXVILLE	5-31-74	89	CP	3	101W1	R0

5.1

4.2

4.3

4.4

...tal Effects of Plant Operation

5.7

5.8

4.2 Socioeconomic Impacts

Acquisition of the Hartsville site will result in the displacement of 11 housing units. TVA's land acquisition policies provide for payment adequate to enable displaced families to reestablish themselves without economic loss. Persons dislocated by the project are eligible for relocation assistance upon proper application.

All properties purchased by TVA are appraised on the basis of the actual property value.

Under the provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, TVA will ensure that there will be available to those displaced by the project comparable replacement dwellings that are decent, safe, sanitary, and reasonably accessible to their places of employment. In addition, provisions for relocation expenses, etc., are provided under this Act.

All of the displaced housing units are associated with active farms. Technical assistance will be offered to these farmers in managing their farms to ensure that the farmer will incur no economic loss during the transitional period. This assistance is offered through the regular agricultural resource development programs or special relocation assistance, if required.

Other impacts will occur in the larger area around the site because a large influx of workers into the area around Hartsville can be expected during construction. Significant impacts will be felt in the housing market with the attendant effects on land use. In addition, a substantial, but temporary, increase in demand for public and private services and facilities will also have to be accommodated especially in the areas of schools, recreation, and health services. This section will put some dimensions on these impacts and outline steps which are being taken to mitigate them.

4.2.1 Magnitude of Impact - Approximately 8 years will be required to complete construction of the Hartsville project, and during its peak employment period there will be about 4,600 TVA employees at the project. Manpower requirements over time are shown in Figure 4.2-1. Table 4.2-1 shows the estimated number of employees projected to move (movers) in relation to total employees and the associated school-age children and total population.

To estimate the number of movers shown in Table 4.2-1, TVA's experience at the Cumberland Steam Plant project was used as a guide. This provided a measure of availability of the five largest crafts (carpenters, electricians, ironworkers, steamfitters, and operating engineers) in the Nashville labor market. From this information and the projected employment in each of these crafts, an estimate of the number of employees to be "imported" at the various times shown was obtained. In addition, an estimate of employees who live within commuting distance but choose to move for convenience or other reasons was prepared. These two figures total to the number shown in the "mover" column. This total ranges from 300 in the first year to 2,600 at peak.

Past surveys of construction workers indicate that the proportion of movers who bring their families has ranged from about 50 percent to 75 percent. Comparing the location of this site with other projects and taking into account the number of movers coming from relatively long distances, it is estimated that 65 percent of the movers will bring their families. School children were estimated using one school-age child per family which, based on survey data, is slightly on the high side. This resulted in an estimated number of school-age children

of 200 after the first year to 1,700 at peak. The total population increase associated with movers and their families is shown in the last column of Table 4.2-1. This ranges from 700 after the first year to 6,000 during the peak.

Impacts on the education systems were made assuming an even distribution of the school-age children among all age levels. This results in an additional 130 children for each grade level K-12 at peak. Based on the state teacher-pupil ratio of 1:25 for grades K-3, these 520 children will need 21 classrooms; for grades 4-12, the state teacher-pupil ratio of 1:30 demands another 39 classrooms for the remaining 1,170 students expected at the peak of construction activities. Transportation of these students could require 28 60-passenger buses. An additional staff of at least 60 teachers is anticipated. Food service, pupil personnel services, administrative staff, desks, textbooks, library books, audiovisual aids and equipment, and supplementary materials are also potential problems.

The above analysis was prepared prior to the recent gasoline shortage and price increases and reflects past commuting patterns which have been rather extensive. However, uncertainties with regard to further price increases and availability as well as the lack of data about the effects on commuting/moving patterns make quantitative estimation of effect inappropriate at this time. However, some qualitative discussion follows to give some "feel" for the problem.

Construction labor in the TVA region appears to be unique in that it is less mobile than in other sections of the country. This arises from a strong tie to home and family and gives rise to the extensive commuting pattern mentioned above. This factor would tend to maintain

the commuting/moving pattern as in the past with only the relatively few, really long-distance commuters causing a shift in the direction of more movers.

A hypothetical commuter from Nashville would have approximately a 100-mile round trip to the Hartsville site. Assuming a car that gets 10 miles to the gallon, this would require 10 gallons of gas. Assuming he would have driven this distance in the not-too-distant past at a cost of 40 cents per gallon, an increase to 50 cents per gallon would entail an additional outlay of $1.00 per day or $5.00 per week.

This increase would probably be insufficient to induce an individual to move his household with its attendant costs, both monetary and social. The increase is also unlikely to cause a family man to locate accommodations in the area for just the work week. Some single workers may find the increased cost sufficient incentive to move into the project area.

An alleviating factor is the tendency toward car pooling. There seems to be an undocumented move toward this, and it would likely offer a feasible alternative for the Nashville area workers. At the Cumberland project, some enterprising employees obtained a bus and transported coworkers from Nashville to the projcct. A similar undertaking might be expected at the Hartsville site.

Given the presently (April 1974) projected gasoline situation, the problem will be one of increased cost but not of availability. While this cost is likely to have some effect on the number of movers, it will probably be small and of relatively little impact.

The above discussion was based on the assumption of gasoline being available at increased cost. However, gas rationing could alter the picture drastically. It would probably preclude commuting for a large proportion of the "local" labor force. A probable result would be an increase in movers and development of a mass transportation system.

4.2.2 Ability of the Area to Accommodate - A desirable characteristic for an impact area to have is for its normal projected growth after construction to be on the order of the estimated employment impacts. Under these conditions, many impact-related mitigation efforts can be programmed to serve long-term growth. However, in the case of the Hartsville project, the combined nonproject-related expected growth of Smith and Trousdale Counties between 1970 and 1980 is 1,000 (from 17,600 to 18,600) and between 1970 and 1990, 3,200. Comparing this with a total projected project-related peak influx of 6,000 persons, it is evident that it would be uneconomical to propose permanent improvements to a level to serve temporary impacts. Thus, a combination of permanent and temporary mitigation measures will be needed.

Education - The Hartsville Nuclear Plant site is located near the Dixon Springs community on the Smith-Trousdale County line, approximately six miles from Hartsville in Trousdale County and nine miles from Carthage in Smith County. In addition to Hartsville and Carthage, communities in the adjoining counties of Macon, Sumner, and Wilson will, in all likelihood, be attractive places for construction workers to locate. Therefore, an analysis of each school system and its ability to accommodate additional students is provided. See attached Table 4.2-2.

Macon County

The Macon County school system has eight attendance centers. Six of the centers provide elementary educational opportunities, kindergarten through grade 8, or some combination, and two centers for high school grades 9-12. The center at Enon is for kindergarten only. The Lafayette Special School houses special education classes. Highway 52 runs east and west through the county roughly midway from the north and south county lines. Three school attendance centers along this route are Westside School, the Lafayette schools in the middle, and the schools at Red Boiling Springs on the eastern edge of the county. Lafayette would be the community most likely to be selected for residence, since this community is approximately 17 miles from the HIIP site. The Lafayette elementary schools can accommodate 1,110 students; the present enrollment is 1,021, thus an additional 89 students could be added. The Lafayette High School has an enrollment of 519 in a building which can accommodate 600 students; this center can provide for an additional 81 high school students.

Smith County

The Smith County school system in the 1973-74 school year had an enrollment of approximately 3,125 students. These students were enrolled in kindergarten through grade twelve (K-12), with 2,225 students in grades K-8 and 900 students in grades 9-12. At present the school system has eleven attendance centers; nine with grades K-8 or combination enrollments, one for grades K-12, and one for grades 9-12. Enrollments in these attendance centers range from a low of 75 to a high of 680.

The average age of the eleven centers is 21.5 years dating from time of original construction. The oldest is 34 years and the newest is 16 years. Several additions were made in the late 1950's, late 1960's, and most recently three centers received additions in 1970. According to a September 1973 report prepared by the State Department of Education at the request of the Smith County Board of Education, these problems were identified in regard to school plant facilities:

1. Too many small schools
2. Crowded conditions and poor buildings
3. Inadequate equipment
4. Lack of preventive maintenance
5. Outdated facilities for the type of program the school system deserves

The State Department of Education has requested positive action on the part of the Smith County officials to rectify the situation. The Smith County Board of Education has endorsed a plan to create a single high school for the county and will present a request to the County Quarterly Court for funds to construct a new high school facility and renovate other buildings. At the present time all school facilities in the county are near to or beyond maximum student capacity. The schools serving the Carthage community are quite crowded.

Sumner County

For the school year 1971-72, the Sumner County school system was the ninth largest in the state with an average daily attendance of 14,348 students. For 1972-73 the average daily attendance was 15,037. From 1960 through 1970 the county experienced a 54.9 percent population increase. With the completion of the new Gallatin Senior High School and the Wessington Elementary School this year, the system has room for some growth. The Gallatin area could accommodate as many as 500 new students. The Sumner County school system at present operates 26 school centers, 17 for elementary grades, 4 for junior high school grades, and 5 for senior high school grades. Of this number Hendersonville and Gallatin each has seven schools. Five other communities scattered throughout the county have the remaining 12 schools.

Trousdale County

The Trousdale County school system has two schools, both located in Hartsville. The elementary school, grades K-6, has a student capacity of 750 with an enrollment in 1973-74 of 615. This school could enroll 135 additional students. The high school has an enrollment of 527 housed in a facility which could enroll 600. Seventy-three students, grades 7-12, can be accommodated. These schools are within four miles of the project in an attractive community. Projected student growth for the Trousdale County schools is minimal. It is expected that the Hartsville community will experience a large increase in temporary residents during the construction phase of the project.

Wilson County

Wilson County is south of the project site offering very attractive communities for temporary residents. The western part of Wilson County is growing rapidly due to new subdivision starts along Interstate 40 just out of Nashville and a host of new communities which have been developed along the shores of Old Hickory Reservoir. The Wilson County school system operates 13 school centers. Ten schools are for elementary grades K-8 or some combination. Three schools enroll students, grades 9-12. There are three school systems in the county; Lebanon City and Watertown offer elementary programs, and the county provides education for all high school students, grades 9-12. Most of the Wilson County schools are at, or exceed, their maximum student capacity. One school operates double sessions. Additions to schools in the western part of the county will temporarily relieve the double session and offer some room for growth. The north part of the county, and the area where new and temporary residency may occur, has three small schools. A small increase in enrollments could be absorbed in this area. The three high schools range in 1973-74 enrollments from 229 at Watertown to 1,415 at Lebanon. Mt. Juliet High School has an enrollment of 1,274 in a facility designed

for 1,080 students. Lebanon High School has recently had an addition and could house another 85 students. It is anticipated that the state will provide an increase in vocational programs, including facilities; thus more student space would become available. Watertown High School could accommodate another 125 students.

Lebanon Special School District

During 1973-74 the Lebanon School Board operated six school centers for grades K-8 or some combination. A new school to open in the fall of 1974 will have space for 800 students. It is estimated that a minimum of 900 students could be housed in the Lebanon schools.

Watertown Special School District

One elementary school, grades 1-5, enrolling 341 students is operated by the Watertown school system. No additional students should be enrolled at this center.

State Schools

The State of Tennessee offers career training at the Hartsville Area Vocational-Technical School. This school needs additional enrollments. The superintendent has offered the services of the school to prepare area citizens for job openings. The Volunteer State Community College at Gallatin has the capability to offer a wide range of programs. A consortium arrangement with area senior institutions and the University of Tennessee at Nashville enables this school to offer an extensive range of learning opportunities.

Housing - Smith and Trousdale counties had about 65-70 vacant houses with complete plumbing for sale or rent in 1970 (1970 Census of Housing). This is clearly inadequate to meet the housing needs of movers and because of the low rate of growth in the area, very little speculative housing on the subdivision scale is built. For example, new housing construction in Hartsville averaged 18 dwellings per year from 1968 through 1972 (Hartsville General Plan, page 64). On the other hand, Sumner County had 528 vacant dwellings and Wilson County, 278 and the major communities in each county, Gallatin and Lebanon, respectively, are experiencing relatively strong rates of growth.

During peak employment, the housing demand would total about 2,000 dwelling units (1,700 for workers with families plus 300 for single workers rooming together). Although conventional housing still tends to be the preferred type of dwelling, mobile homes are being used increasingly by construction workers where other types of housing are not available reaching 45 percent at TVA's most recent projects. This is partly a function of a trend toward locating closer to the project whether or not conventional housing is available. Based on past experience, it would not be unexpected for mobile homes to comprise one-half or more of the housing occupied by construction workers or about 1,000 at peak. Remaining would be a demand for 1,000 conventional dwelling units in relatively close proximity to the site.

Conventional housing needs will be met largely in Sumner County, especially in the Gallatin area. The highway from Gallatin to the plant site is good and with the bypass around Hartsville makes the 20-mile trip a 25- to 30-minute journey. Wilson County and Lebanon offers a secondary source of conventional housing but the highway connections are poorer. The shortest route follows a winding, low speed road while the faster route gets closer to Gallatin than Lebanon before turning south towards Lebanon. In addition, available conventional housing in the surrounding communities and countryside will be sought out and occupied.

Mobile homes are expected to be located much closer to the site in Trousdale, Smith, and Macon Counties. Some mobile home park development is occurring in the area but it does not approach the magnitude of 1,000 mobile home spaces. Mobile home regulations exist only in Hartsville thus creating the potential of substandard mobile home developments occurring in the remaining area.

Traffic - State Highway 25 carried an average daily traffic (ADT) load of about 2,100 vehicles in 1972. The capacity for this type of road ranges from about 3,500 to 5,000 ADT. Peak construction traffic would add about 2,600 to the ADT which, combined with existing ADT, would total 4,700. This would be a significant increase in traffic and possibly result in an overload condition from an ADT standpoint.

Since construction employee traffic will be concentrated during the periods just before and just after working hours, an analysis of hourly capacity provides another viewpoint on potential impact. A road of this type can accommodate from 1,150 to 2,000 cars per hour. This indicates that the highway is likely to be able to accommodate the estimated 1,500 cars associated with the change of the day shift. A mitigating factor is that the employees will be coming from both the east and west and an access road will be available at each end of the site. This will tend to reduce traffic conflicts.

Some problems of congestion and delay can be anticipated in Hartsville and Carthage. Commuters from the west must pass through Hartsville and from the east, through Carthage.

Health Facilities - A current shortage of physicians, other primary providers, and facilities exists in the area around the site (Smith and Trousdale Counties), especially in Trousdale County. As of May 1973, only one physician was practicing in Trousdale County and six in Smith County. Three small unaccredited hospitals serve the area. The Hartsville General Hospital has 34 beds, Carthage General Hospital contains 29 beds, and the Smith County Hospital 43 beds, including one coronary care unit and one intensive care unit. Emergency medical services (EMS) are being

improved in Trousdale County as part of a program of the Mid-Cumberland Health Planning Agency. This program is to create a regional EMS communication net. Improvements are still needed in the areas of EMS staffing and equipment.

4.2.3 Mitigation Strategies - Definitive programs for helping the area accommodate the socioeconomic impacts have not been developed at this time. However, below are a number of strategies under consideration which have been or will be discussed and evaluated with state and local bodies having relevant authority and expertise to implement. The fundamental objective in guiding mitigation program development is to minimize the adverse socioeconomic effects. To the extent possible, this objective will be achieved in such a manner as to provide long-term benefits to the area.

Education - Objectives of mitigation efforts would be to maintain the state teacher-pupil ratio, adequate classroom space, and transportation facilities. Efforts to prepare teachers and administrators to cope with the temporary student population may include seminars and inservice education opportunities.

Classroom space will be the major problem during the construction years of this project. It is recognized that control of the residential location of the worker is undesirable, if not impossible, yet attempts will be made to disperse the impact throughout the area. This might be possible through information bulletins provided at the time of employment. Information could be provided on the availability and type of housing and the ability of school systems to accommodate various grade level students. Hartsville and Carthage are likely to need temporary school facilities

in large numbers. TVA, in consultation with State officials, will investigate the feasibility of establishing a "capital outlay items pool" (relocatable classrooms, equipment, and buses). Such a pool could serve this project and other needs for temporary housing and busing. It often occurs that school systems for various reasons due to fire, storm, etc., need a temporary solution on short notice. For school systems with plans or needs for expanding, consideration will be given to providing financial assistance in the amount which would be expended for temporary facilities.

Transportation of students will require additional buses. Assuming a large number of construction workers commute to the project, bus pools could be established for worker transport with the same buses used between work hours for school busing.

Housing - As discussed above, conventional housing demands by construction workers can reasonably be expected to be met. However, it is expected that roughly 1,000 mobile homes will have to be accommodated in the project area with little potential for sale of the mobile home or demand for mobile home spaces after construction. Presently there are no regulations to control this type of development in Smith or Trousdale Counties with the exception of Hartsville. In the absence of appropriate regulations, the provision of these temporary accommodations could have adverse consequences on land use in the area and possibly create health and sanitation problems. For these reasons, TVA will take positive steps to encourage the local governments to develop a planning program including uniform mobile home regulations.

To encourage the establishment of local planning programs where none presently exist, TVA will provide, on request, one-half of the first year local cost for technical planning assistance contracts with the Tennessee State Planning Office (TSPO). In addition, TVA technical planning assistance will be available to both the new as well as ongoing local planning programs.

In addition, TVA is evaluating a demonstration proposal for temporary housing. Working in conjunction with the local planning programs and local development interests and anticipating project-related housing needs, TVA will identify and promote various alternatives for accommodating temporary, mobile home housing. Assuming the adoption and enforcement of local mobile home regulations (using the existing Hartsville zoning ordinance as the example), TVA will analyze the economics of privately developed mobile home parks in the area. This analysis will estimate costs of development and the necessary rental rates in the context of the temporary demand situation assuming a complete writeoff of capital investment.

As an alternative to writing off the necessary capital investments of a mobile home development, TVA is considering participation in a demonstration program for the permanent use of these facilities. The basic concept of this demonstration is the interim use of tracts of land for mobile homes but with the water, sewer, roads, etc., laid out and sized to accommodate future permanent uses. Two of the most promising applications appear to be conventional subdivisions and industrial sites.

In the subdivision approach, a conventional layout is prepared including the type and orientation of the structure to be built ultimately on each lot. Then, a mobile home layout at densities two to four times

the ultimate densities is overlayed on the subdivision, making maximum use of the various improvements. For example, the parking areas for the mobile homes could become the driveway, garage pad, and patio of a permanent house built after the mobile homes are removed. Such ultimate housing could be either low-cost public housing or higher income housing, depending on local market requirements when the conversion takes place. In the industrial site case, the same basic development approach is used.

Another objective of the housing program is to influence the distribution of the temporary population to: (1) make the best use of available public facilities and services and (2) to reduce commuting distances. Thus, if the demonstration programs prove to be desirable and needed, they will be coordinated with the other socioeconomic mitigation programs being developed for the area.

Traffic - Initial efforts will be directed towards encouraging car pools and possibly development of some sort of mass transportation facilities. Due to the initiative of employees shown at other projects, notably the Cumberland project mentioned above, TVA's direct involvement may be small. However, TVA will investigate the feasibility of alternative programs for reducing traffic.

To reduce the impact of traffic on Hartsville and Carthage, TVA technical assistance will be available to these communities on methods to expedite the flow of traffic at peak periods.

An important strategy for reduction of congestion in the two communities is tied to the temporary housing program. In simple terms, housing could be located between the two communities and the

Hartsville site. While this approach may not be universally applicable, it can be used to substantially reduce the amount of traffic through the towns.

Health - To alleviate the shortage of medical facilities in Trousdale County, TVA is exploring the upgrading of facilities in Trousdale County to provide first-class primary care. Efforts will be directed toward creating plans and interagency arrangements for transfer of patients and clients to other facilities for necessary services not available locally. This would include upgrading EMS facilities.

It is anticipated that concentrating these programs in Trousdale County can best serve the needs arising from the project and at the same time upgrade the health services of the area. Improvements to health services in Smith County will be explored to complement rather than duplicate the program outlined for Trousdale County.

Table 4.2-1

Estimated Movers, School-Age Children
and Total Population Associated with Construction
Employment at the Hartsville Nuclear Plant

Year After Construction Begins	Employment		Population Increase	
	Total	Movers	School Age	Total
1	1,200	300	200	700
2	2,700	1,100	700	2,500
3	4,000	2,100	1,400	4,900
4	4,600	2,600	1,700	6,000
5	3,700	2,000	1,300	4,600
6	1,700	700	450	1,600

Table 4.2-2

HARTSVILLE NUCLEAR PLANT (HNP) REPORT

SCHOOL ENROLLMENT INFORMATION

School System	No.	School	Grade Organization	Enrollment 1973	Maximum Capacity
Macon County	1	Central Elementary	5-8	477	480
	2	Enon Consolidated	K	88	120
	3	Fairlane (Lafayette)	1-4	544	630
	4	Lafayette Special	SMR	7	
	5	Red Boiling Springs Elem.	K-6	340	390
	6	Westside Elementary	K-8	282	300
	7	Red Boiling Springs H.S.	7-12	264	390
	8	Macon County H.S.	9-12	519	600
Smith County	9	*Carthage Elementary	K, 3-8	659	540
	10	*Cox Davis	1-8	114	165
	11	*Defeated	K-8	129	150
	12	Forks River	1-8	233	255
	13	Gordonsville Elementary	K-6	335	320
	14	New Middleton	1-8	111	120
	15	*Pleasant Shade	1-8	79	120
	16	South Carthage	1-8	78	90
	17	*Turner	1-2	223	225
	18	*Union Heights	1-8	185	195
	19	Gordonsville H.S.	7-12	344	300
	20	*Smith County H.S.	9-12	680	600
Sumner County	21	Beech	K-6	369	300
	22	Bethpage	K-6	171	180
	23	Doss Jr. H.S.	7-9	916	735
	24	Gallatin Jr. H.S.	8-9	821	840
	25	Gallatin Sr. H.S.	10-12	977	800

Table 4.2-2 (continued)

HARTSVILLE NUCLEAR PLANT (HNP) REPORT

SCHOOL ENROLLMENT INFORMATION

School System	No.	School	Grade Organization	Enrollment 1973	Maximum Capacity
Sumner County (cont.)	26	Guild	5-6	649	630
	27	Hawkins Jr. H.S.	7-9	890	525
	28	Hendersonville Elementary	K-6	1,185	600
	29	Hendersonville Sr. H.S.	10-12	1,370	1,200
	30	Howard	K-2	767	810
	31	Lakeside Park	K-6	772	720
	32	Millersville	K-6	283	240
	33	Nannie Berry	K-6	833	600
	34	North Portland	K-3	551	540
	35	North Sumner	K-8	226	240
	36	Oakmont	K-6	160	120
	37	Portland Jr. H.S.	7-9	545	540
	38	Portland Sr. H.S.	10-12	449	500
	39	South Portland	4-6	546	510
	40	Union Elementary	2-3	597	630
	41	Union 7th Grade	7	443	450
	42	Vena Stuart	4-5	673	570
	43	Walton Ferry	K-6	873	720
	44	Westmoreland Elementary	K-6	550	480
	45	Westmoreland H.S.	7-12	450	540
	46	White House H.S.	7-12	687	600
	47	Wessington Elementary			750
	48	New Gallatin H.S.			1,400
Trousdale County	49	*Trousdale County Elementary	K-6	615	750
	50	*Trousdale County H.S.	7-12	527	600

Table 4.2-2 (continued)

HARTSVILLE NUCLEAR PLANT (HNP) REPORT

SCHOOL ENROLLMENT INFORMATION

School System	No.	School	Grade Organization	Enrollment 1973	Maximum Capacity
Wilson County	51	Carroll	1-8	135	120
	52	Gladeville	1-8	166	120
	53	LaGuardo	1-5	47	60
	54	Lakeview (double sessions)	K-6	980	480
	55	Lebanon H.S.	9-12	1,415	1,500
	56	Mt. Juliet Elementary	K-5, 7-8	1,274	1,080
	57	Mt. Juliet H.S.	9-12	931	850
	58	Oakland	K-8	77	90
	59	Southside	K-8	503	600
	60	Tuckers X Roads	1-8	145	150
	61	Watertown H.S.	9-12	234	360
	62	Watertown Jr. H.S.	K, 6-8	229	210
	63	West Elementary	5-6	304	270
Lebanon Special School District	64	Byars Dowdy	1-6	619	600
	65	Highland Heights	1-6	600	600
	66	Lebanon Ed. Center	K-5 & Spec. Ed.	137	300
	67	Lebanon Jr. H.S.	7-8	701	500
	68	McClain Elementary	K-6 & Spec. Ed.	498	450
	69	Sam Houston	K-6	569	660
	70	W. J. Baird Middle School	7-8	800	800
Watertown Special School District	71	Watertown Elementary	1-5	341	330

5.1 5.2 4.3 4.4 ...mental Effects of Plant Operation 5.7 5.8

Table 4.2-2 (continued)

HARTSVILLE NUCLEAR PLANT (HNP) REPORT

SCHOOL ENROLLMENT INFORMATION

School System	No.	School	Grade Organization	Enrollment 1973	Maximum Capacity
State	72	*Hartsville Area Vocational-Technical School		115	210
	73	Volunteer State Community College			

All schools listed are in communities which could be impacted by HNP construction work force.

*Schools within ten miles of HNP site.

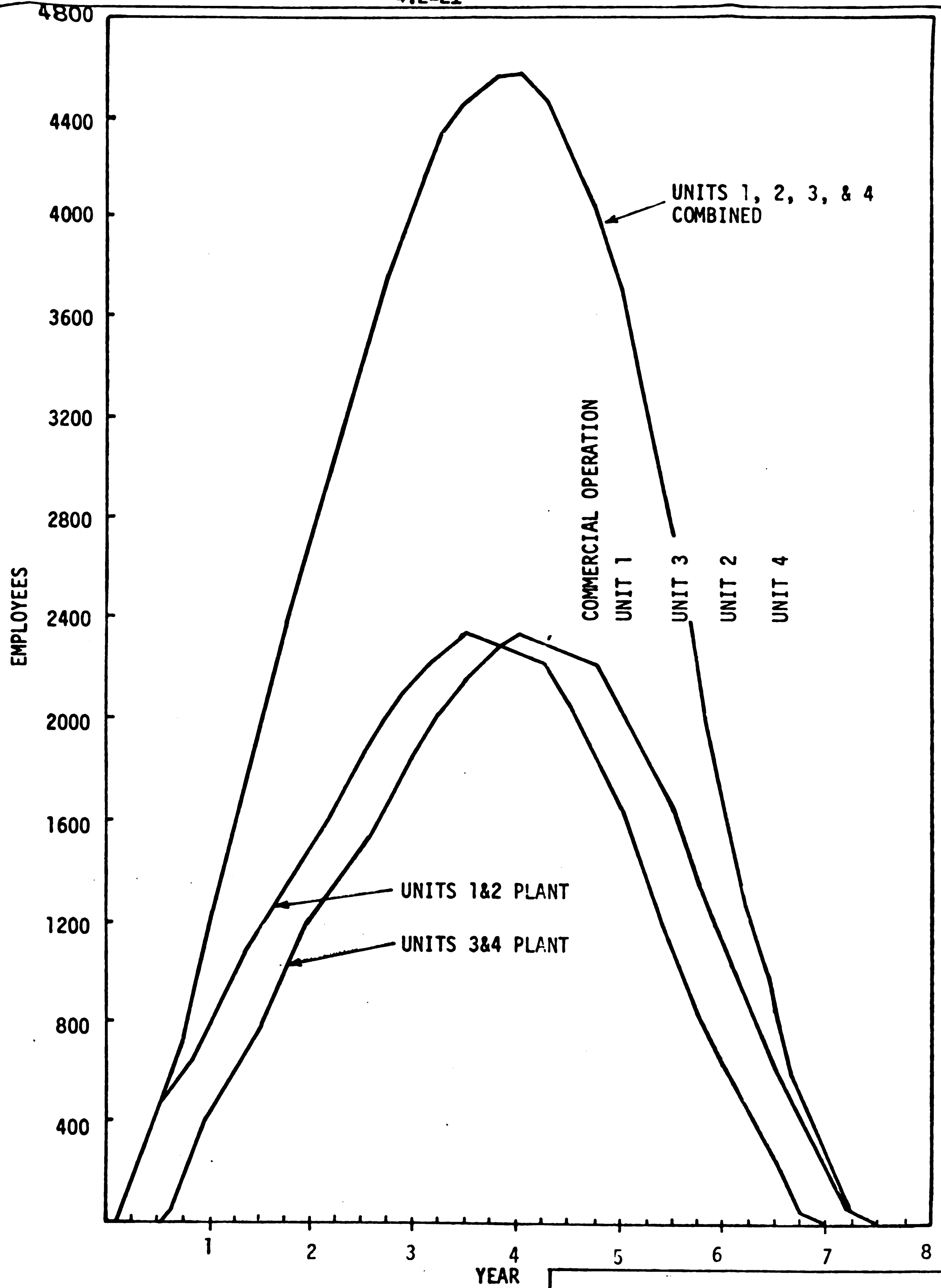


Figure 4.2-1

MANPOWER ESTIMATES FOR TWO
2-UNIT NUCLEAR PLANTS
AT COMMON SITE

5.1 5.2 4.3 4.4 al Effects of Plant Operation 5.7 5.8

4.3 Transmission Line Construction

Proposed transmission line connections to the Hartsville Nuclear Plant will interact with the environment in the areas traversed. While clearing of the right of way corridors and construction of the transmission lines will result in environmental impact, these impacts are not expected to be significant. A discussion of the probable impacts associated with transmission line construction follows.

4.3.1 General Considerations for Locating Transmission Lines -

As a first step in the transmission line location process, topographic maps are examined in the office to determine the best apparent route. In some cases, these maps are supplemented with aerial photographs to assure that the most up-to-date knowledge of land use developments is available. Then a field reconnaissance is made using these maps and photographs.

In the field, engineers first look for the best places to cross major highways and secondary roads, at the same time avoiding, to the extent possible, residential, commercial, and industrial areas; recreational areas and other developments; and areas of historical, cultural, or scenic significance. Locations on crests of mountains and ridges are generally avoided to minimize visual impacts.

Following completion of the engineering survey which will provide a definitive location of the line, competent archaeologists and historians are consulted. If any significant properties would be adversely affected by transmission line construction, the line location is reevaluated and in the case of archaeological artifacts, their recovery is considered.

The transmission line structures are then located along the proposed route with full benefit of these consultations. Where the route crosses major highways, rivers, and other bodies of water, the structures are located to minimize visibility. Additional structure height may be provided to allow screens of existing vegetation to remain under the line at these and other sensitive areas.

4.3.2 Impacts of Transmission Line Rights of Way Clearing and Construction Practices -

Shear Clearing - In constructing transmission lines through wooded areas, TVA "shear clears" the right of way (clearing of trees and other vegetation to the ground level) except where outcropping of rocks, in proximity to streams and road crossings, steep slopes, and other critical areas make it impractical. Hand clearing or spanning of vegetation is utilized where these exceptions are encountered. In the shear clearing process, large stumps are totally removed from the ground. This facilitates the movement of construction and maintenance equipment along the right of way and avoids the necessity of constructing an extensive system of access roads to each tower location (see Section 4.3.9, Access Road Construction). Also, removal of stumps alleviates the continual problem of rapid regrowth which can occur when well developed root systems are left in place.

While the removal of vegetation from the right of way by shear clearing constitutes an impact on terrestrial plant and animal communities existing in the corridor area, the impact of shear clearing will be localized because the land pattern traversed by this proposed route is

alternately open farmland, pasture land, and wooded areas. The impact is further reduced by TVA's practice of reseeding the right of way with pasture-type grasses and also by the natural invasion by weeds and plants during subsequent growing seasons. For additional discussion of construction clearing and seeding practices, refer to Appendix L1 (General Right of Way Clearing and Seeding Specifications).

To further reduce the need for controlling brush growth and to minimize the environmental impact of a cleared right of way, an intensive effort is made to encourage the landowner to maintain an appropriate grass or wildlife food and cover or to utilize the area for row crops when consistent with his use of adjoining land. Such uses enhance the appearance of the right of way and at the same time provide agricultural production and wildlife benefits.

Impact on Flora - The major impact to flora will result from the clearing of brushland and forested areas. These land cover types will be altered to brushland which can be termed a short rotation brush community situation where plant succession continues for 3-5 years until further maintenance of the right of way is required.

Where practicable, merchantable timber along the proposed right of way corridors will be marketed during clearing operations. The present estimated value of timber that will be removed is $247,000 as indicated on the following table.

	Pulpwood		Sawtimber	
Hardwood	13,230 cds.	$19,845	4,608,827 bd. ft.	$205,092
Conifers	1,740 cds.	9,135	239,420 bd. ft.	12,928
Total	14,970 cds.	$28,980	4,848,247 bd. ft.	$218,020

The projected economic loss of timber productivity based on 1973 timber values and 45 cu. ft. of wood per acre per year, is an estimated $15,854 or $6.86 per acre per year, as indicated on the following table.

	Pulpwood		Sawtimber	
Hardwood	878 cds/yr.	$1,317	296,698 bd. ft./yr.	$13,203
Conifers	97 cds/yr.	509	15,287 bd. ft./yr.	825
Total	975 cds/yr.	$1,826	311,985 bd. ft./yr.	$14,028

Although some economic loss of timber production will result from this clearing, it is possible that this loss can be offset by converting the cleared land into uses that would provide an equal or higher return than timber production. For a further discussion of potential replacement land uses, see Section 5.6.3, Multiple Use of Rights of Way.

Impact on Terrestrial Fauna - The construction of the transmission facilities will have an impact on certain fauna, owing to habitat disturbance during initial construction and subsequent maintenance work. Species inhabiting open areas where vegetation removal will not take place (pasture, cropland, etc.) will not be significantly affected by construction, operation, and maintenance procedures (e.g., grasshopper, sparrow, meadow lark, cottcn rat). In areas where major vegetation removal will take place such as old fields and second growth deciduous and coniferous forests, significant impacts to certain faunal species will occur (e.g., flying squirrels, pine mouse, wood rat, pine warbler, worm-eating warbler, and wood thrush). These impacts will be short-term or temporary for species preferring early plant successional habitats such as brushland (e.g., yellow breasted chat, prairie warbler, cottontail rabbit, skunks, and numerous reptiles), but permanent or long-term displacement will occur for others (e.g., wood thrush, summer tanager, red-eyed vireo, wood rat, flying squirrel).

Adverse impacts associated with shear clearing on vertebrates will be most pronounced to species dependent on second growth pine and hardwood forest types for their livelihood. Species favoring open and brushy situations, as well as edge areas, will be benefited.

Impact on Waterfowl - Except where the corridors cross Old Hickory Lake (Cumberland River), they generally pass through upland areas that are seldom if ever utilized by waterfowl. Although the proposed corridors do not traverse established waterfowl management areas, the Old Hickory Lake Canada goose flock is now expanding to outlying areas. Construction of the transmission facilities in the vicinity of Old Hickory Lake will be scheduled so that effects during nesting and hunting season will be minimized if practical.

Impact on Rare and Endangered Species - Rare, endangered, unique, or unusual species or habitats are not known to occur within or adjacent to the proposed corridors.

Impact on Fauna - No large old growth stands of pine were encountered which could provide habitat for the red-cockaded woodpecker (*Dendrocopun borcalis*). Southern bald eagles (*Halisectus leucocephalus*) have been known to migrate through the region. Nesting activity is rare but could occur along major stream courses. American osprey (*Pandion haliaetus carolinenis*), a threatened bird, could also be found along streams and lakes. None have been noted however. The endangered Indiana bat (*Myotis sodalis*) could exist in limestone caves occurring in the region. No caves have been noted along the corridors.

4.3.3 Land Use Impact - The use of land for these transmission line corridors may in localized areas conflict with existing or proposed land uses. However, the small amount of land occupied by

supporting structures is the only part of the right of way that cannot be used for any other purpose. Generally, on flat land, 500-kV transmission line towers occupy approximately 0.18 acre of land per mile of length. The remainder of the right of way must only be kept clear of obstructions and is available for a variety of other uses, some of which have been mentioned previously. Virtually all agricultural uses can be continued. Once this power line is built, no future timber production will be permitted for the life of the line, although the establishment of ornamental and orchard trees is allowed with certain height restrictions. Merchantable size trees in areas to be cleared will be marketed where possible.

4.3.4 Social and Economic Impacts - Considering the limited land and natural resources available for present and future goals, the use of high-voltage transmission facilities avoids the necessity of building a number of smaller lines, with less efficient use of land and raw materials. For example, one 500-kV transmission line can transmit more power than ten 161-kV lines but requires only twice as much right of way as one 161-kV line. The use of high-voltage transmission facilities better serves the large generating facilities required in an expanding electrical system. The continued availability of a reliable supply of electric power is also of economic and social importance.

Construction of the proposed transmission lines may also have adverse social impacts through displacement of some homes and other structures, minor interference with cultivation practices, and disruption of other human activities. Of these impacts, displacement of homes is probably the most significant. Every effort has been

made to avoid route locations which pass through existing residential areas or near farmsteads. With the increasing concentration of electric power requirements near densely populated areas, some disruption of residential areas is often unavoidable. Should family relocations be required, assistance will be provided in accordance with Public Law 91-646, "Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970."

Any damage to fences, gates, roads, bridges, and other structures will be paid for or repaired by TVA following construction, and landowners will be reimbursed by TVA for any damages to land, as well as for the value of crops damaged by construction or later maintenance activity.

<u>4.3.5 Impacts on Aesthetics</u> - Both the transmission line and the cleared rights of way have some visual impact. TVA makes every effort to route proposed transmission lines through open areas; however, part of central Tennessee is heavily wooded and it will be necessary to traverse some 2,300 acres of forest land. It will also be necessary for these transmission lines to traverse or pass in close proximity to Old Hickory Reservoir, Overall Creek, and several major highways. In siting the proposed route, TVA avoided to the maximum extent practical areas known for their scenic and recreational values. Special attention will be given to the detailed design of the transmission line crossings of areas that cannot practicably be avoided. Care will be taken to locate towers well back from river banks, and tower heights will be selected so that, in localized areas where required, trees and other vegetation can be left undisturbed. Efforts will be made to reduce visual impacts at all major road crossings, particularly at interstate

highways, by revegetation, employing angles in the line to avoid a corridor effect, and preserving existing vegetation in the vicinity of the crossings.

As discussed in Section 2.3.2, a portion of the Harpeth River is designated as a wild and scenic river and a section of the Duck River is scheduled as a recreation waterway. Special considerations will be given in designing, clearing, and constructing the transmission facilities at these crossings. Adequate vertical and horizontal clearances will be provided to allow for vegetative spanning and no brushing or clearing will be performed for a minimum of 100 feet on either side of the rivers except for an occasional extremely tall tree which would make vegetative spanning impracticable. Other suggestions included in the publication Environmental Criteria for Electric Transmission Systems[1] will be considered and incorporated on the design of these lines where practicable.

4.3.6 Impact of Support Facilities - In order to keep pace with the growing demand for power, it is necessary to add substantially to both generating capacity and bulk power transmission facilities. To meet the anticipated power requirements in central Tennessee, 500-161-kV bulk power substations will be needed in the following general areas: The Columbia area (Maury), the Clarksville area (Montgomery), and the Tullahoma area (Franklin). These facilities will become part of the transmission terminal support facilities for the nuclear plant.

To provide data acquisition channels, telephone service, supervisory control and telemetering functions and pilot relaying and protection channels for integrating the additional transmission facilities associated

with the Hartsville Nuclear Plant into the overall TVA power system grid, additions to TVA's existing microwave control system will be required.

To meet the minimum system reliability requirements, microwave connections into the Hartsville Nuclear Plant will be provided via two different routes. Figure 4.3-2 schematically depicts the general location of these facilities and their relationship with existing microwave connections in the immediate area.

To receive or transmit microwave signals from one station to another, an unobstructed line of sight is essential. When either natural or manmade structures obstruct the line of sight some means of circumventing the obstruction must be used. This can be accomplished either by installing a passive repeater designed to deflect or redirect the microwave signals around the obstacle or by installing an active type repeater station which receives, amplifies and retransmits the microwave signals.

One connection into Hartsville will require the installation of a passive repeater station approximately 0.6 mile north of the nuclear plant on property purchased for the nuclear plant. The passive repeater station will consist of a 24-foot by 30-foot billboard type passive reflector located within a fenced area approximately 50-feet square. Total clearing will be limited to the site for actual placement and construction of the facility. Selective clearing, removal of tall trees outside of this 50-foot area will be required to provide an unobstructed line of sight. This would connect the transmission facilities control system into the existing Russell Hill Microwave Station approximately 12 miles east northeast of the Hartsville plant site. Lower growing trees and brush which will not interfere with the line of sight will be retained.

The second connection would be established by way of a new, two-hop, microwave system to be installed between the Hartsville Nuclear Plant and the South Nashville 161-kV Substation with a proposed intermediate active-type repeater station to be located approximately 5.5 miles north northwest of Lebanon, Tennessee, near the community of Oakland, Tennessee.

The installation of the active repeater site near Oakland, Tennessee, will require the purchase of a 5.5 acre site at the location shown on Figure 4.3-1. Access to the site will be provided by the gravel road which follows along the lower slopes of the selected knoll. A short section (approximately 800 feet) of new access will be required from the existing road to the top of the knoll. No potential erosion problems are anticipated since the land is open and presently in permanent pasture. The repeater station will consist of a fenced metal building approximately 10 feet by 20 feet and a 350-foot guyed laced tower. In accordance with standard FAA regulations, aircraft hazard painting and lighting will be installed on the proposed tower.

To ensure that the proposed microwave repeater station is compatible with area plans, the proposed site will be coordinated with the Tennessee State Planning Commission-Regional Planning office and the Mid-Cumberland Council of Governments.

4.3.7 Solid Waste Disposal - TVA contracts most right of way clearing for the construction of transmission lines. Where practical, merchantable timber is marketed. Disposal of the remaining forest slash cleared from rights of way generally is by open burning. Open burning of slash along the proposed transmission corridors to Hartsville will be performed in compliance with local, state, and Federal air pollution guidelines and ordinances. This will result in the release of some particulates

and gases into the atmosphere. However, these minor effects will be localized and generally short lived. In locations where disposal by burning is not desirable, slash will be piled in windrows along the edge of the right of way.

In general, other solid waste that may be generated by constructing this transmission line will be very small. These minor construction waste items will consist of protective wood cribbing attached to conductor reels, cardboard shipping cartons and steel bands used to bind tower structural items and other line hardware. This waste will be returned to staging areas for disposal.

At staging or material assembly points, relatively large quantities of the used packing material which accumulates will be transported to state-approved sanitary landfills or dumps. However, in localized areas, smaller quantities of wood and paper will be disposed of by controlled burning.

<u>4.3.8 Erosion Control Practices</u> - Construction of these transmission lines will involve the use of heavy equipment for tower erection and stringing of conductor. Although this equipment may cause temporary rutting along the rights of way, precautionary measures will be taken so that the effects of soil erosion on local water quality is not significant. The erosion of local areas will be controlled to a significant degree by: (1) using special construction procedures which limit the use of heavy equipment in areas of high erosion potential, directing runoff from exposed land to settling ponds, and keeping vegetation on the land as long as possible before construction; and (2) scheduling construction activities in swampy or wet areas to coincide with favorable dry weather conditions.

When line construction activity is completed, the rights of way will be contoured and seeded with pasture-type grasses or planted in wildlife food and cover to control soil erosion and provide wildlife habitat.

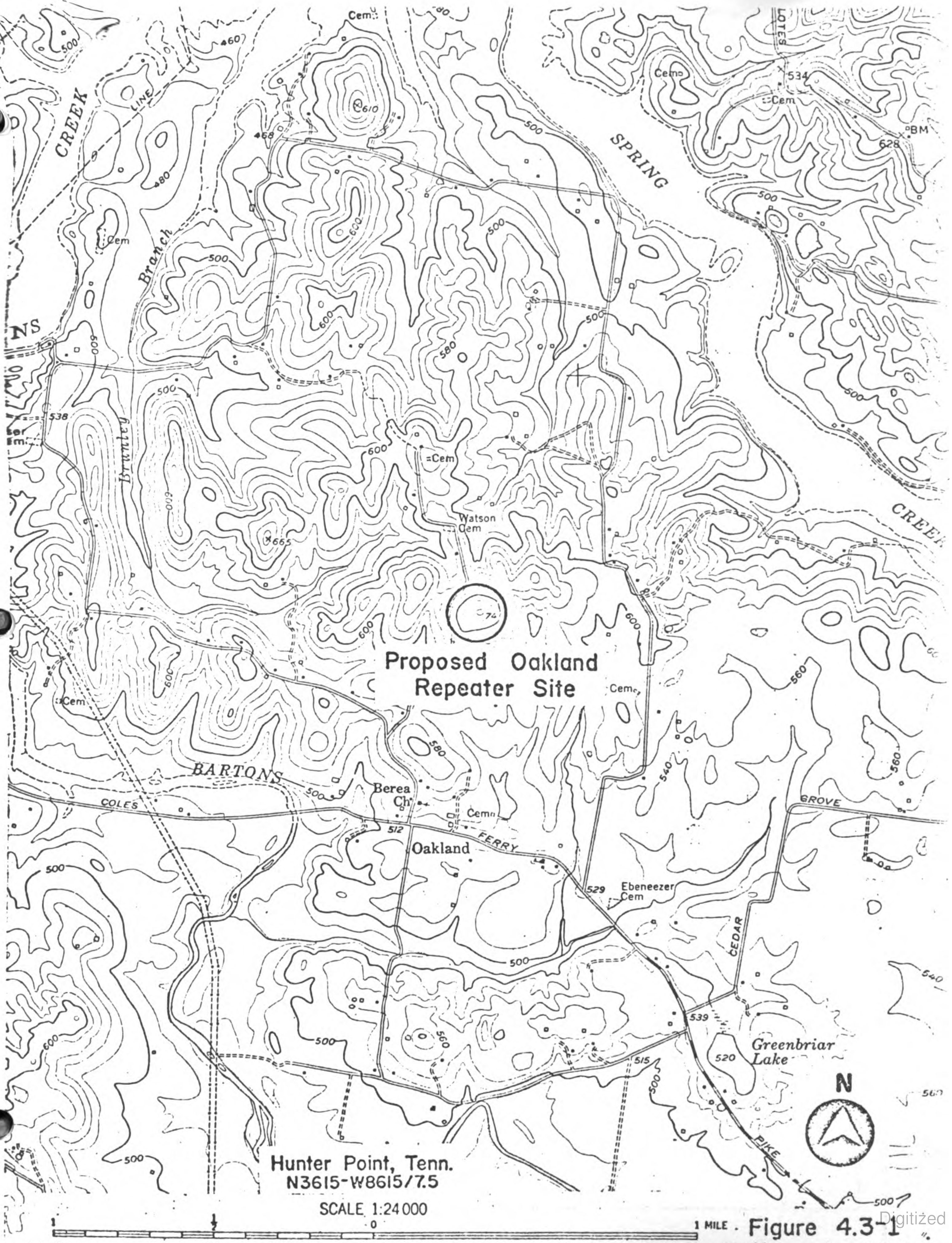
Access road routes will be selected to minimize damage to existing growth and drainage ditches, water breaks, terracing, and ground cover will be provided in order to minimize soil erosion.

4.3.9 Access Road Construction - During construction, access roads will be held to a minimum and efforts will be made to limit them to the tower sites. All tower sites, however, cannot be located adjacent to existing roads (field, farm, county, or state) to provide reasonably easy access. The pattern of existing roads in a particular area largely determines the number, length, and location of required access roads.

Until the exact tower locations are determined by the design process, the number, length, and location of access roads cannot be accurately determined. For constructing the transmission line connections to Hartsville, it is estimated that new access roads will average two per mile, 0.3 mile in length and 12 feet in width. Where an access road is necessary, visual impacts and soil stability will be prime considerations, and access will be designed to minimize both.

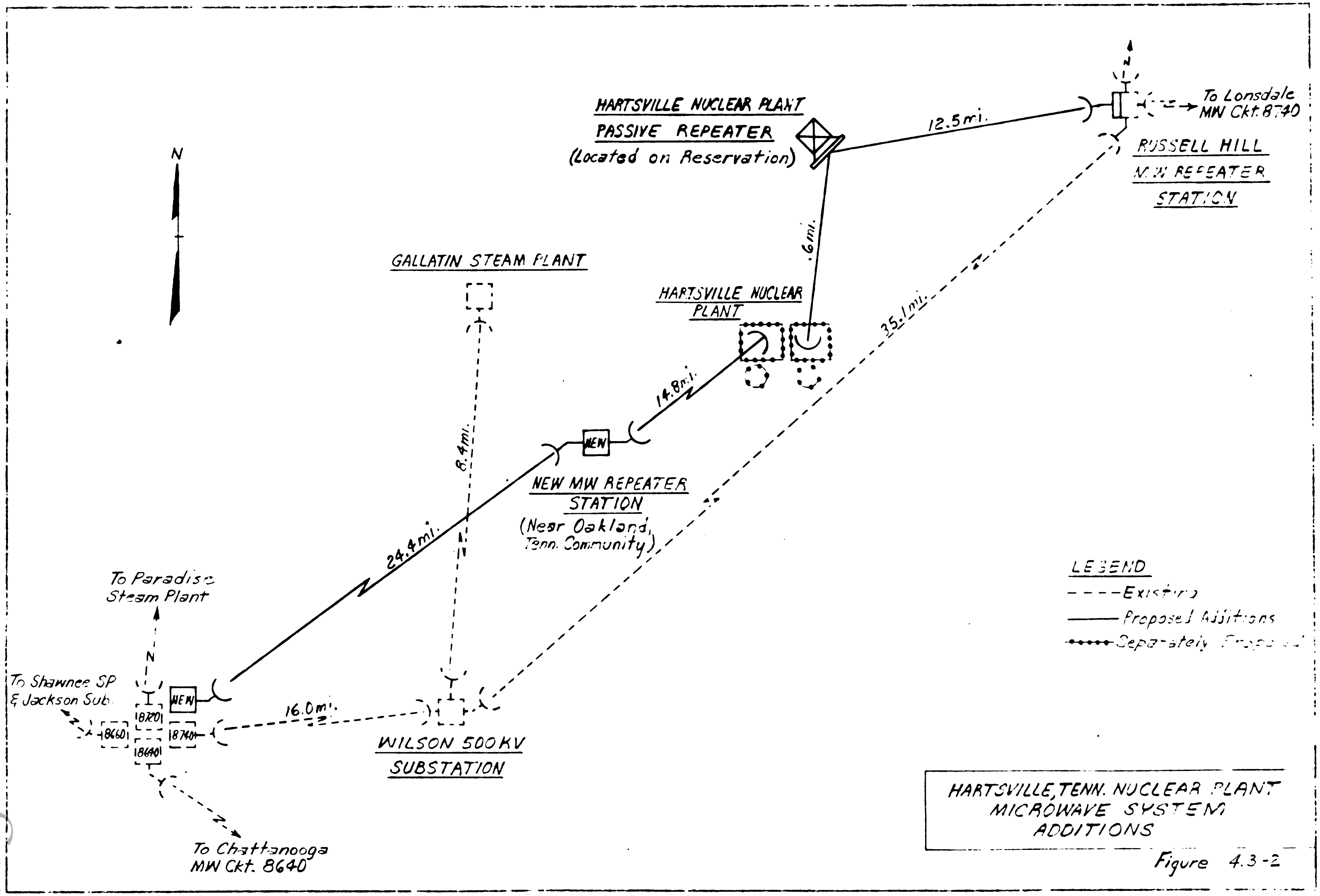
REFERENCES FOR SECTION 4.3

1. U.S. Department of the Interior and U.S. Department of Agriculture, Environmental Criteria for Electric Transmission Systems, Washington, D.C., U.S. Government Printing Office, 1970, 0-404-932.



Proposed Oakland Repeater Site
CREEK
LINE
Branch
SPRING
CREEK
Brantley
Watson Cem
Cem
BARTONS
COLES
Berea Ch
Oakland
FERRY
Ebeneezer Cem
CEDAR
GROVE
Greenbriar Lake
PIKE
BM
N
Hunter Point, Tenn.
N3615-W8615/7.5
SCALE 1:24000
1 MILE

Figure 4.3-1



HARTSVILLE, TENN. NUCLEAR PLANT
MICROWAVE SYSTEM
ADDITIONS

Figure 4.3-2

5.1 5.2 5.3 4.4

ntal Effects of Plant
Operation

5.7

4.4 Commitment of Resources Due to Plant Construction

4.4.1 Loss of Land - The commitment of land involved in construction of the plant and related facilities is temporary in nature; and while it will be altered by construction activities, this does not represent irreversible or irretrievable losses of the land resource. Of the 1,940 acres acquired for the plant site, the powerhouse complex including switchyard and cooling towers will occupy approximately 300 acres. Two temporary construction areas adjacent to the plant will occupy approximately 150 acres each. Planned transmission facilities will utilize an additional 5,400 acres of land. The access railroad will require about 75 acres for the line and about an additional 60 acres for borrow areas.

Other lands within the exclusion area of the plant will be altered by construction but revegetated when construction is completed, while others will be altered by cessation of existing agricultural operations.

Because most of the affected area is in agricultural use, the effect on the terrestrial communities is not considered significant. The long-term effect will be increased diversity and complexity of terrestrial communities. The loss of agricultural land for the life of the plant will be a commitment of resources, but this commitment represents a commitment of an insignificant amount of land compared with the available agricultural land in the region (see section 2.2.2).

Several areas on the site are suitable for industrial development, and much of the site is also suitable for residential development.

It does not appear that any of the site would necessarily lose its suitability for residential or industrial use although it would depend, to some extent, on the final disposition of the physical plant and related facilities, e.g., whether the structures were torn down. Thus, there would be insignificant permanent loss of land for industrial, residential, or agricultural purposes as a result of constructing the plant and related facilities.

The use of land at this site for plant and transmission facilities will not adversely affect present or future recreation activities. To some extent, construction of the nuclear plant should enhance area recreation by providing the visitors' center and overlook.

4.4.2 Nonrecyclable Construction Materials - The major nonrecyclable construction materials committed to the project are concrete, including reinforcing steel and other embedded items. Quantities involved are in the range of 600,000 yd^3 of concrete; 30,000 tons of reinforcing steel bars; and miscellaneous embedments such as structural equipment anchorages, pipe, electrical conduit and boxes, waterstops, etc. Also, other materials which may be used for architectural treatment of buildings such as roofing, floor coverings, plastering, etc., may not be reclaimable.

Construction of the plant will also require the commitment of amounts of gasoline, diesel oil, electricity, and other energy resources required for operation of construction equipment and facilities. Minor amounts of various chemicals used throughout the project for such things

as water treatment, preservatives, possible chemical cleaning of piping and equipment, etc., will be consumed and hence irretrievably committed.

Other major construction materials used, such as steel, wiring, and equipment, could be salvaged and recycled and therefore would not be irreversible and irretrievable commitment of resources.

4.4.3 Destruction of Biota - Some commitment of resources will occur due to the destruction of biota caused by construction of the plant. This destruction may include direct destruction due to mechanical operations, blasting, and other construction activities, and indirectly by the disturbance of the natural habitat.

The Hartsville site has been used intensively by man for agricultural purposes for many years. Heavily fenced, it consists chiefly of pasture, cropland, and understocked woodland. Human activities, particularly land cultivation have continually disrupted natural plant communities and interrupted natural ecological succession leaving little of the area in a relatively undisturbed state. No rare or unusual species or floral associations have been observed during studies to date. Therefore, construction techniques discussed in section 4.1 such as avoiding much of the few attractive wildlife areas such as Dixon Island and the upland areas in the northern part of the site will minimize the destruction of habitat and displacement of faunal species.

It is expected that approximately 350 acres of terrestrial habitat will be lost due to the paving, building construction, and excavation of the permanent facilities and approximately an additional 350-400 acres

for the temporary construction facilities. Wooded areas constitute about 25 acres of this committed habitat. The habitat loss within the permanent plant area is considered an irretrievable loss, but the construction areas will be committed only during the time of construction. After cessation of activity, they are expected to become productive habitat.

In addition to the areas on site, about 75 acres of habitat will be committed by construction of the access railroad. As with the plant site, most of the wildlife habitat is relatively unproductive farm land from a habitat standpoint, and construction of the railroad will not cause a significant loss. Crossings will occur over Goose Creek and an unnamed creek which are richer habitat areas. The crossings will occupy only a small portion of the total habitat of these areas and will not result in a significant loss when compared to the habitat available in the region.

Some additional habitat may be committed offsite as land use changes alter existing habitat. Part of these areas will be committed only during the construction period.

Construction of transmission lines will commit habitat for only a short period. During actual construction, some habitat will be lost, but it will return to productive use soon after completion of construction.

Construction of the barge slip, intake, and discharge will require a commitment of some waterfowl habitat. Proper location of these to avoid the habitat areas as discussed section 4.1 will serve to minimize this commitment.

Construction activities will result in short-term commitments of aquatic biota and habitat. Losses of larval fish are expected to occur due to disturbance of habitat areas in the construction of the intake, discharge, rail access, and barge slip. Adult fish losses are expected to be minimal as they tend to avoid high turbidity areas.

In the areas to be affected, the benthic biota have sparse populations. Localized planktonic activity will be suppressed during construction but, due to the short generation times for the plankton, will rapidly replenish after completion of the construction activity. Therefore, the commitment of this biota which is irretrievably lost will be only that biota which is lost during the actual time of construction. This is felt to be insignificant when compared to the total population in the locale due to the small area affected and low relative importance of the affected areas compared to other areas within the immediate environs.

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5.0 Environmental Effects of Plant Operation

5.7 5.8

5.1 5.2 5.3 5.4 5.5 5.6 5.7

5.1 Effects of Operation of Heat Dissipation System

5.1.1 Physical Effects of Heated Water Discharge - Four nuclear steam-electric units rated at 1,220 MW electrical (gross) each will be built at the Hartsville site. Operating at rated capacity, the thermal load which must be removed by the heat dissipation system is approximately 9,400 MW for the four units. Approximately 4,000 ft^3/s of water will circulate through the condensers from the closed-cycle cooling tower circuit. As described in section 3.4, closed-cycle natural draft cooling towers were selected as the proposed heat dissipation system, and the discharge system will utilize a multiport diffuser to disperse blowdown into the river.

As a result of closed-cycle cooling tower operation, the only water returned to the Cumberland River will essentially be from two sources--blowdown from the condenser cooling water system and blowdown from the essential service water system. However, since the essential service water heat will be dissipated via a closed-cycle spray pond arrangement and its blowdown requirement is only about 1.1 ft^3/s per plant, essentially all of the physical effects of heated water discharge will be a result of the blowdown from the natural draft cooling tower system.

For 4-unit operation, the blowdown from the natural draft towers will average 111 ft^3/s with a maximum of approximately 126 ft^3/s. The temperature of the blowdown may vary from 10° F. below the river temperature to 40° F. above the river temperature, depending upon the relative magnitude of the wet bulb air temperature and the river temperature. For the purpose of estimating the impact of the blowdown

discharge, conservative values of 110 ft^3/s blowdown rate and 50° F. difference in blowdown and ambient river temperatures were used in the discharge plume study as outlined in Appendix J. Appendix J provides a detailed discussion of the impacts due to heated water discharges into the Cumberland River.

Based upon field and laboratory model experience with similar diffusers at TVA's Browns Ferry Nuclear Plant[1], the multiport diffuser discharge is expected to mix completely with the fraction of the river flow passing over the diffuser sections. This feature makes the dilution achieved a function of: (1) diffuser length; (2) ratio of the river flow to the blowdown discharge; and (3) the lateral distribution of the river flow. In this manner, a dilution factor of at least 10 can be achieved with the multiport diffuser. This dilution is sufficient to meet presently applicable water temperature standards. In reaching this finding, the study as described in Appendix J assumed that blowdown will only be discharged when the river flow is 3,600 ft^3/s or greater, corresponding to the minimum turbine release from the upstream hydro plants. River flows less than 3,600 ft^3/s may be sufficient to provide the necessary dilution for the blowdown discharge, depending upon the length of the diffuser, which will be determined on the basis of field measurements of water velocity distributions at the site. Similarly, the details of the diffuser pipe diameters, port size, and port spacing, will be based on future, more detailed studies. The conclusions relative to the induced thermal regime presented in the study are not sensitive to those details of the diffuser design.

The configuration of the mixing zone shown on Figure J-4 for the multiport diffuser adjacent to Dixon Island will also be appropriate

for a diffuser located downstream from Dixon Island. The downstream location is proposed since it minimizes impacts to fish and wildlife around Dixon Island. The mixing zone is expected to extend 150-200 feet downstream from the diffuser and to be confined to the bottom half of the river depth. Heated water leaving the mixing zone will rise vertically and spread laterally, forming a surface layer. The upstream extent and temperature distribution in this intermediate region of the plume will depend strongly upon the river flow and is not known quantitatively; however, the temperature rise in this region will be less than the maximum rise corresponding to the dilution requirement. A calculated estimate of the range of average surface temperature rise in the far field downstream from the discharge is presented in Figure J-6 of Appendix J and will be valid for the multiport diffuser located downstream of Dixon Island.

The actual thermal regime induced in the Cumberland River will vary in response to changes in river flow, blowdown discharge, and blowdown temperature rise. However, the impact of the discharge on water temperature will not exceed the thermal regime described above which is based on conservative values of these parameters, i.e., maximum blowdown discharge and temperature rise and minimum river flow.

<u>5.1.2 Thermal Standards</u> - Thermal standards for the reach of the Cumberland River on which the Hartsville site is located were established by the Tennessee Water Quality Control Board and approved by the Environmental Protection Agency. These standards were published as part of the "General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee" and can be found in Appendix B3,

Water Quality Standards. The particular thermal standard which applies at the Hartsville site states that:

> The maximum water temperature change shall not exceed 3° C. relative to an upstream control point. The temperature of the water shall not exceed 30.5° C. and the maximum rate of change shall not exceed 2° C. per hour. The temperature of recognized trout waters shall not exceed 20° C. There shall be no abnormal temperature changes that may affect aquatic life unless caused by natural conditions. The temperature of impoundments where stratification occurs will be measured at a depth of 5 feet, or mid-depth whichever is less, and the temperature in flowing streams shall be measured at mid-depth.

Water temperature measurements to determine compliance with this standard shall be made in accordance with the following definition and interpretation:

> Mixing Zone - Mixing zone refers to that section of flowing stream or impounded waters necessary for effluents to become dispersed. The mixing zone necessary in each particular case shall be defined by the Tennessee Water Quality Control Board.
>
> Insofar as practicable, the effect of treated sewage or waste discharges on the receiving waters shall be considered after they are mixed with the waters and beyond a reasonable zone of immediate effect upon the qualities of the waters. The extent to which this is practicable depends upon local conditions and the proximity and nature of other uses of the waters.

5.1.3 Biological Effects of Intake

5.1.3.1 Fish - The cooling water intake will result in impingement and entrainment of fish. These effects will be minimized by the selected location and design of the intake facility and by the use of closed-cycle cooling towers. The intake will be located at a deep, midchannel position and thus will avoid impacting rich, shallow areas around Dixon Island and the mouth of Dixon Creek. Since larval fish sampling of the Old Hickory Reservoir has not been

completed, no empirical larval fish abundance data are available. However, an approximation has been derived by extrapolation from Wheeler Reservoir where extensive sampling of larval fish has been conducted.

At a depth of 5 meters, Wheeler Reservoir is estimated to have a density of 88.77 larval fish/m^3 over a 91-day period of availability. This value was reduced by two-thirds to compensate for the lower productivity of Old Hickory Reservoir in the vicinity of the Hartsville site. Using this procedure, a larval fish concentration of approximately 29.59 larval fish/m^3 over a 91-day period is estimated for this portion of Old Hickory Reservoir. On this basis, it is expected that approximately 16 million larval fish would be entrained during the 91-day period of availability of larval fish.

The calculated value is probably greatly overestimated due to the deepwater location of the intake structure at approximately reservoir elevation 422 (near the bottom of the river channel).

Mortality of entrained larval fish is assumed to be 100 percent because of the high temperature differential (delta t), mechanical damage due to pumping and passage through the cooling towers, and the long retention time under closed-cycle operation. Because of the depth of the intake and its location away from the shoreline overbank areas, impacts on post-larval size fishes will be minimal.

The current sampling program to establish baseline values and the program to be used to assess effects is described in section 6.

<u>5.1.3.2 Other Aquatic Life</u> - Since the plant will have a closed-cycle mode of cooling, all of the aquatic organisms that pass through the intake screens will be destroyed. The forms of aquatic life

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that will be affected in addition to fish include phytoplankton, zooplankton, and planktonic veligers of Asiatic clams (Corbicula).

The loss of aquatic life should be insignificant even if loss is assumed to be proportional to the intake flow and assuming that the organisms are evenly distributed. However, the proposed deepwater intake will reduce this loss below that expected for a surface intake.

The amount of plankton lost will vary seasonally because of climatic variations and varying life cycles of different planktonic forms. Phytoplankton losses should be made up within a few days and zooplankton in a few weeks.

5.1.4 Biological Effects of Discharge

5.1.4.1 Fish - The location and design of the discharge structure, along with compliance with applicable discharge guidelines, are expected to result in minimal impacts on fish. Only that area in the immediate vicinity of the discharge diffuser would be expected to pose any difficulty due to relatively high velocities, high temperatures, etc.

5.1.4.2 Other Aquatic Forms - Water returned to the Cumberland River will be mostly from blowdown from the condenser cooling water system. Since the solids from all systems will be sufficiently diluted to meet established standards and the heated discharge will be mixed with the reservoir water to meet current established thermal regulations, benthic and planktonic organisms are expected to suffer little or no deleterious effects.

5.1.5 Effects of Rate of Temperature Change of Receiving Water - Assuming a minimum flow of 3,600 ft^3/s with the proposed deepwater multiport

diffusers, blowdown discharge will produce a mixing zone approximately 200 feet wide, 15 feet deep, and 150 feet long in which delta t will exceed 5.4° F. With a temperature differential going from a maximum of 50° F. at the diffuser pipe to less than 5.4° F. 150 feet downstream, the mixing zone temperature gradient is steep. With a stream velocity of .75 ft/s at mean daily flow of 17,000 ft^3/s, larval fish entrained in the jet mixing zone will experience exposure to a delta t greater than 5.4° F. for a maximum of about 6 minutes. Precise effects of exposure of larval fish to such elevated temperatures are unknown; but, since the top of the mixing zone is about 15 feet below the surface and covers less than half the river channel, impacts upon larval fishes are expected to be minimal. Post-larval fish will probably exhibit an avoidance to the turbulence in the immediate vicinity of the diffuser pipe. Some fish may selectively position themselves in the heated waters at the lower end of the mixing zone and in the heated plume below because of temperature preferences and the availability of plankton and larval fish killed during passage through the condensers. Sudden cessation of heated discharges could induce thermal shock in these fish. However, this should have no significant influence on the total reservoir fishery.

Although the specific schedule for plant shutdown for refueling operations is unknown, it is anticipated that refueling of each nuclear unit will occur every 12 months. Under normal operating conditions, only one unit at a time will be shut down and the reduction of heat discharge occurring in a short period of time under these conditions would be about 25 percent.

Outside the mixing zone, heated waters with a temperature above ambient of less than 5.4° F. will rise and expand laterally above unmixed

river waters, and at some point downstream will become mixed vertically. Forty miles downstream, delta t is estimated to be only 1° F. Since current temperature regimes of the Cumberland River in the Hartsville area are lower than usually encountered in warm water fisheries, projected temperature increases should have a beneficial effect by increasing the productivity of fish and other warm water aquatic organisms in that area.

Some shifts in relative abundance of species may occur, but the principal effect expected is the enhanced utilization by fishes of main channel waters. Since the mixing zone occupies less than one-half the channel width and depth, no barrier to migration is expected in that area.

5.1.6 Fog and Ice - This subsection evaluates the potential for fogging and icing for the natural draft cooling towers at the Hartsville Nuclear Plant.

The evaluation of the plume lengths for the cooling towers was based on a TVA model developed from observations of plumes from the natural draft towers at the TVA Paradise Steam Plant in Kentucky and from meteorological data from the Paradise meteorological station and the National Weather Service (NWS) rawinsonde station near Nashville, Tennessee. This plume length model has been used to evaluate the potential plume lengths for cooling tower alternatives at the TVA Browns Ferry, Sequoyah, Watts Bar, and Bellefonte Nuclear Plant sites.

The Paradise plume length model was adjusted to account for the larger evaporation rates for the Hartsville cooling towers.

For a given evaporation rate, the length of a visible plume is directly proportional to the moisture content of the ambient air and inversely proportional to the magnitude of the absolute humidity deficit. In the calculation of the daily plume lengths and directions, the 1200 GMT meteorological data from the Nashville NWS rawinsonde station (about 28 miles west-southwest of the Hartsville site) for the period January 1973-January 1974 and the design maximum evaporation rates were used. Since dew point was not measured onsite, the temperature and dew point data were obtained from the Nashville rawinsonde records.

For the natural draft (wet) plume length and direction calculations, the Nashville rawinsonde data were used. Nine absolute humidity deficit values were calculated from interpolated values of dry bulb temperature and dew point at 200-foot intervals from 400 to 2,000 feet aboveground and averaged to obtain the mean absolute humidity deficit for the layer. The corresponding 9 wind direction values for the layer were averaged to give the estimated plume direction. The natural draft cooling towers were treated as a point source of water vapor which was assumed to be near the center of the plant site.

The expected plume lengths and frequency of occurrence by sector for natural draft cooling towers are shown in Figures 5.1-1 and 5.1-2. Plume roses for all cases (all temperatures) and those for cases with temperatures equal to or less than 32° F.[a] are shown. (A "case" is defined as any day

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a. The percentages on the plume roses for temperatures $\leq 32^{\circ}$ F. are smaller than normally expected by about a factor of 2 or 3, because the abnormally mild year had less than one-half the normal number of days at or below freezing.

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for which plume length and plume direction were obtained from the 1200 GMT meteorological data for the period February 1973-January 1974.) Optimum conditions for fogging usually occur during the 5-hour period, 0300 to 0800 local time (LT). The number of cases for each sector is multiplied by 5 hours to obtain the estimated number of hours per year of potential fogging from the visible vapor plumes.

Average daily traffic volume data for 1972 for roads in Macon, Smith, Trousdale, and Wilson Counties in Tennessee were used in estimating the number of vehicles per year that might be affected by fogging and icing from the operation of the cooling facilities.[2]

River fogging from the heated water discharge associated with blowdown was analyzed. Daily riverwater temperature data, wind speed data (165 feet aboveground), and dry-bulb temperature and relative humidity data (4 feet aboveground), collected at the TVA Gallatin Steam Plant (15 miles west of the Hartsville site) for the period April 1972-March 1973, were used in an empirical model for estimating the occurrence of river steam fogging. The model was initially developed for application to the Green River at the Paradise Steam Plant in Kentucky and modified for application to the Old Hickory Reservoir on the Cumberland River adjacent to the Hartsville site.

The calculated annual number of hours of river fogging due to the blowdown is conservative. Data on flow rates in the Old Hickory Reservoir, primarily related to discharges from Cordell Hull Dam upstream, are not available on an hourly or diurnal basis. The flow rates often vary from near zero to near maximum during any given day, but related information on the timing, duration, and transition periods is not available. The

magnitude of river temperature rise from blowdown is dependent on the volume of water flowing past the blowdown discharge structure and the attendant mixing of the heated water discharge. Since near zero flow rates had to be considered, a 5° F. rise in river temperature (near maximum allowable) was assumed for all hours of the day and applied to the river fogging model. Obviously, there was an appreciable over-estimate of the hours of occurrence of river fogging due to blowdown discharges. The results did not include the hours of natural river fogging which were also predicted by the model. Also, the hours of river steam fog potentially hazardous to river traffic were not restricted to the optimum period, 0300-0800 LT, identified with fogging from the natural draft cooling tower plumes. Any hour of the day that fog was predicted by the model was considered valid.

The annual average frequency of occurrence of heavy fog (1/4 mile visibility or less) observed at the National Weather Service Office at Nashville was considered in the estimates of hours of potential heavy fogging. This is a reduction of 17 days, or cases, per year.[3]

Rime icing associated with the plumes or steam fog is not expected to present any problem from operation of natural draft cooling towers.

Drift from the cooling towers will be kept to a minimum by drift eliminators and probably would not reach the ground or other surfaces beyond 2,000 feet from the towers. Accumulation of glaze ice will be limited to structures within a few hundred feet of the towers and might have some adverse impact on plant structures. TVA's experience with the natural draft towers at the Paradise plant indicates that few, if any, drift droplets reach the ground. During infrequent conditions of water

vapor saturation of the layer of air from the surface to 500 feet or more, much of the drift that escapes the eliminators might reach the ground. In many such cases, natural rain would be falling and drift deposition probably would not be discernible.

Ground Transportation - The relatively high-level releases from the natural draft towers should have no effect on ground transportation. Observations at the TVA Paradise Steam Plant as well as observations by other researchers[4] show that natural draft plumes usually evaporate before reaching ground level in areas of relatively flat or gently rolling terrain. Since most roads in the Hartsville area are located on flat or gently rolling terrain or in valleys between 200- to 400-foot hills, no significant effects on ground transportation are expected. Plumes would predominantly move toward the north through east sectors (Figure 5.1-1). No rime icing on roads or bridges is expected.

Water Transportation - Because of the relatively high-level releases from the natural draft towers, river traffic would not be affected by the plumes. Steam fogging from blowdown discharge into Old Hickory Reservoir could affect river traffic about 497 hours annually. Effects would be most pronounced over the river immediately downstream from the plant site in the area of the maximum river surface temperature rises due to the blowdown discharge.

Air Transportation - Analysis of the predicted natural draft tower visible plume behavior shows that maximum plume lengths should be about 9 miles. Since no airports are located within 10 miles of the Hartsville site, no interference with airport operation is expected.

5.1.7 Other Impacts -

5.1.7.1 Cooling Tower Drift - Terrestrial plant and animal life within the influences of cooling tower plumes may be affected by changes in moisture and chemical regimes from drift. Little is known regarding moisture and chemical effects related to drift although several drift salt effect analyses have been attempted.[5,6,7] Data and results from these studies are not easily applied to Tennessee Valley conditions. Chemicals transported in drift water droplets will consist of those that are in the river water plus those added in the cooling system. The overall chemical load should be alkaline, consisting primarily of carbonates and sulfates. Changes in plant growth rates, species diversity, disease, parasite infestations, and other problems could be postulated as resulting from moisture alterations. These changes would probably be subtle, long-term, and extremely difficult to disassociate from other cause and effect phenomena.

5.1.7.2 Elevated Structures - Tall stacks, natural draft cooling towers, or other high structures could have adverse effects on migrating songbirds and waterfowl. Several studies, including two at TVA plants, are under way to determine the extent of impacts on birds caused by elevated structures. At TVA's Paradise plant, three tall stacks (over 700 feet) and three natural draft cooling towers are being monitored. Also, an 800-foot stack at TVA's Bull Run plant is being monitored. Data gathered for several years at the Lake Erie Davis-Besse site indicate these effects are minimal.[8] Preliminary TVA data also indicate minimal effects.

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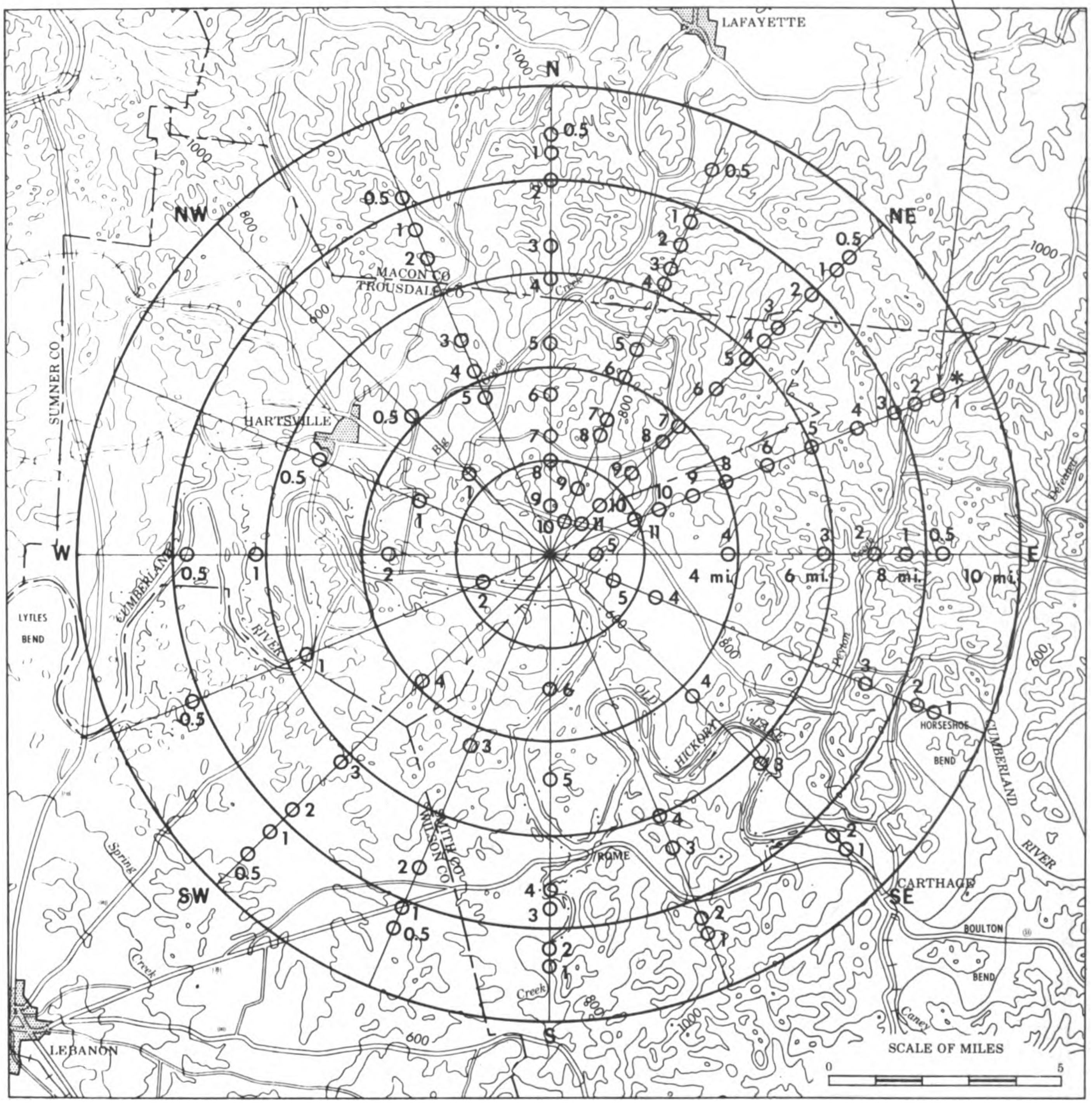
*Example: In 1 percent of the total cases plumes extend 9 miles or more in the 22-1/2° sector ENE of the site.

Percent of total cases



Based on early morning record
February 1973 – January 1974

Figure 5.1-1 EXPECTED PLUME LENGTH AND FREQUENCY OF OCCURRENCE FOR 16 COMPASS POINT SECTORS
NATURAL DRAFT (WET) COOLING TOWERS
(ALL TEMPERATURES)
HARTSVILLE NUCLEAR PLANTS

*Example: In 0.3 percent of the total cases plumes extend 7.7 miles or more in the 22-1/2° sector NE of the site.

Percent of total cases

Based on early morning record
February 1973 — January 1974

Figure 5.1-2 EXPECTED PLUME LENGTH AND FREQUENCY OF OCCURRENCE FOR 16 COMPASS POINT SECTORS NATURAL DRAFT (WET) COOLING TOWERS (TEMPERATURES ≤32°F) HARTSVILLE NUCLEAR PLANTS

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5.2 Radiological Impact on Biota Other Than Man

5.2.1 Exposure Pathways - Exposure pathways for organisms other than man originate with either liquid or gaseous effluent releases and result in doses from external and internal routes. External pathways include submersion in air and water and exposure to soil and sediment. Internal exposure results from the ingestion of food or water and the inhalation of air. The primary exposure pathways are shown in Figure 5.2-1.

Doses to aquatic organisms from radionuclides deposited internally are generally of greater magnitude than the doses from external sources of radiation. Radionuclides are incorporated into tissues of aquatic organisms either through the assimilation of food or through the direct penetration of dermal tissue. External radiation exposures to aquatic organisms are due primarily to radioactivity in solution or associated with suspended particulates. Benthos receive an additional external dose from radionuclides adsorbed onto or concentrated in the benthic substrate.

Internal doses to terrestrial animals are generally of greater magnitude than the doses received from external sources. These internal exposures result primarily from radionuclides ingested with food and water and from the inhalation of airborne radioactivity. Terrestrial plants receive small internal exposures from radionuclides absorbed through their dermal layers and root systems. Terrestrial organisms receive the largest external exposure from submersion in air containing radioisotopes of iodine, krypton, xenon and their daughter products. Radionuclide concentrations in soil and vegetation, due to

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deposition from the atmosphere and to radionuclides entering through the water supply, are minor contributors to the external dose. An additional exposure is attributable to direct radiation from radioactivity contained within the nuclear plant.

5.2.2 Radioactivity in the Environment - Analyses for the following representative organisms and pathways are performed to determine the potential radiological impact of the Hartsville Nuclear Plant.

Aquatic Organisms	- external exposure from water
	- external exposure from sediment
	- internal exposure
Terrestrial Vertebrates	- external exposure from air
	- external exposure from ground or water
	- external exposure from direct radiation
	- internal exposure from ingestion or inhalation
Terrestrial Plants	- external exposure from air
	- external exposure from ground
	- external exposure from direct radiation

Because of the complexity of biological functions and the interrelationships between organisms and their environment, simplified dose models have been developed to predict doses resulting from the more significant exposure pathways. Conservative assumptions are chosen because these models cannot predict the detailed variances of a system and because the results of an analysis cannot be applied equally to all members of a population. A brief outline of the

models, methods of calculation, and basic assumptions is provided in this section. Dose estimates are based on the average annual activities of radionuclides expected to be released during normal operation of the Hartsville Nuclear Plant (section 3.5).

1. <u>Liquid Effluents</u> - The assumption is made that aquatic biota are exposed to radionuclide concentrations in the river near the liquid effluent diffusers. Using flow data for the Cumberland River measured during 1922-71, dilution in the river near the nuclear plant is calculated using an average flow of 17,600 ft^3/s and mixing with one-half of the riverflow. The resulting average annual concentrations of radionuclides are listed in Table 5.2-1. For comparison purposes, average annual radionuclide concentrations in the plant effluent prior to mixing in the Cumberland River are also listed.

   <u>Terrestrial Vertebrates</u> - In general, aquatic plants such as green algae concentrate trace elements to a greater extent than do fish and invertebrates.[1] Therefore, maximum potential internal dose estimates for terrestrial vertebrates are computed for ducks and muskrats with diets consisting entirely of green algae from algal masses growing near the water discharge structures. Equation 5.2-1, derived from equations 1 and 2 of Appendix I1, is used for estimating the annual internal total body dose to ducks and muskrats.

$$D_1 = 51.2 \times 10^3 \, I_i \, f_{wi} \, \varepsilon_i \, (1-\exp(-\lambda_i T))/\lambda_i m, \text{ mrad}, \qquad (5.2\text{-}1)$$

where

$51.2 \times 10^3 = (1.6 \times 10^{-8}$ g-rad/MeV) $(3.20 \times 10^9$ dis/μCi-d) $(10^3$mrad/rad),

I_i = 333 g/d x C_{wi} x F_{pi} x 365 d, μCi,

C_{wi} = water concentration, μCi/g,

F_{pi} = concentration factor for aquatic plants, dimensionless,

f_{wi} = fractional uptake, dimensionless,

ε_i = effective energy absorbed per disintegration of the i^{th} radionuclide including daughter products, MeV/dis,

λ_i = effective decay constant, $days^{-1}$,

T = 1,825 days,

m = 1,000 g.

The duck and muskrat are assumed to have a mass of 1,000 g, an effective radius of 10 cm, and a daily intake of 333 g of green algae. Long-lived radionuclides such as Cs-137 can deliver significant portions of the total dose commitment long after the time of ingestion. Therefore, a life span of five years is assumed for the integration interval T. In the absence of data applicable specifically to ducks and muskrats, ICRP data[2] are used for the fractional uptake and for the biological half-life of parent radionuclides. The use of human data for biological half-lives is considered to be conservative because warm-blooded vertebrates smaller than man exhibit more rapid elimination rates.[3]

The duck and muskrat are assumed to be exposed continuously by full immersion in the water. External dose rates are estimated using the equation:

$$R_i = 51.2 \times 10^3 \, C_{wi} E_i, \text{ mrad/d,} \qquad (5.2\text{-}2)$$

where

E_i = average effective energy emitted by the i^{th} radionuclide per disintegration, MeV/dis.

<u>Aquatic Plants, Invertebrates, and Fish</u> - Radioactivity deposited internally in these organisms is estimated by multiplying the average water concentration in the Cumberland River near the point of discharge by the applicable concentration factors[1, 3, 4]

listed in Table 5.2-2. Doses are estimated for organisms having effective radii of 3 cm and 30 cm. In the absence of detailed knowledge of the dynamic behavior of radioactive daughter products that are produced internally, all daughter products are assumed to be bound permanently in the organisms; and every daughter in a decay chain is assumed to decay at an equilibrium disintegration rate equal to the disintegration rate of the parent nuclide. The annual dose from the i^{th} radionuclide is calculated using the equation:

$$D_i = 51.2 \times 10^3 \, C_{fi} \, \varepsilon_i \times 365d, \text{ mrad,} \qquad (5.2\text{-}3)$$

where

C_{fi} = radioactivity concentration in the organism = $C_{wi} \times F_i$, µCi/g,

F_i = concentration factor, dimensionless.

External doses for organisms immersed in water are calculated using Equation 5.2-2. Benthic organisms such as mussels, worms, and fish eggs receive additional external doses from radioactivity associated with bottom sediments. Accurate prediction of the accumulation of radioactivity in sediment and the resultant doses to benthic organisms requires detailed knowledge of a number of factors, including mineralogy, particle size, exchangeable calcium in the sediment, channel geometry, waterflow patterns, chemical form of the radiocompounds, and behavioral characteristics of the organisms. In the absence of this detailed knowledge, external doses from radioactivity associated with bottom sediment are calculated as described in Appendix I1 assuming a 4-π geometry for beta doses and a 2-π geometry for gamma doses.

2. Gaseous Effluents - In the evaluation of the potential impact of gaseous effluents on terrestrial organisms, biota are assumed to be located near the site boundary in the WSW sector, where the maximum average annual radionuclide concentrations in the air and on the ground are predicted. Estimates of air and ground concentrations listed in Table 5.2-3 are calculated as described in Appendix I1.

A cow is assumed to be located on the nearest grazable land in the sector having the maximum average annual radioiodine concentration. The equation used to calculate the cow thyroid dose from the inhalation and grass ingestion exposure pathways is:

$$D_i = (C_{ai} \times DF_{ai}) + (C_{gi} \times DF_{gi}) \text{ , mrad,} \qquad (5.2\text{-}4)$$

where

C_{ai} = average air concentration, $\mu Ci/cm^3$,

C_{gi} = average ground concentration, $\mu Ci/m^2$,

DF_{ai} = dose factor for inhalation, mrad per $\mu Ci/cm^3$,

DF_{gi} = dose factor for ingestion, mrad per $\mu Ci/m^2$.

Air and ground calculations are calculated as described in Appendix I1, and the dose factors for iodine isotopes are derived from references 5 and 6.

External doses to terrestrial organisms from air submersion and ground contamination are estimated using dose factors derived for humans. It is assumed that total body dose factors for humans are applicable to terrestrial vertebrates and that skin dose factors for humans are applicable to terrestrial plants and small fauna. An additional component of external radiation exposure due to direct radiation from the nuclear plant is calculated as described in Appendices I3 and I4.

5.2.3 Dose Estimates - Dose estimates for aquatic plants, aquatic invertebrates, and fish are listed in Table 5.2-4. Estimates for terrestrial organisms are listed in Table 5.2-5. These estimated doses for biota are below the dose limits established for occupational workers in the nuclear industry.[7, 8] In the "BEIR" report,[9] it is stated that " . . . probably no other living organisms are very much more radiosensitive than man, so that if man as an individual is protected, then other organisms as populations would be most unlikely to suffer harm."

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Table 5.2-1

AVERAGE RADIONUCLIDE CONCENTRATIONS IN LIQUIDS

Nuclide	Plant Effluent (μCi/g)	Cumberland River[a] (μCi/g)
H-3	2.0 (-6)*	2.6 (-8)
Na-24	8.0 (-13)	1.0 (-14)
P-32	8.0 (-15)	1.0 (-16)
Cr-51	2.0 (-13)	2.6 (-15)
Mn-54	1.6 (-14)	2.0 (-16)
Mn-56	2.0 (-11)	2.6 (-13)
Fe-59	3.2 (-14)	4.1 (-16)
Co-58	2.0 (-12)	2.6 (-14)
Co-60	2.0 (-13)	2.6 (-15)
Ni-65	1.2 (-13)	1.5 (-15)
Zn-65	8.0 (-16)	1.0 (-17)
Zn-69m	1.2 (-14)	1.5 (-16)
Br-83	5.2 (-12)	6.6 (-14)
Br-84	1.1 (-11)	1.4 (-13)
Br-85	7.2 (-12)	9.2 (-14)
Sr-89	9.3 (-13)	1.2 (-14)
Sr-90	6.8 (-14)	8.7 (-16)
Sr-91	2.2 (-11)	2.8 (-13)
Sr-92	4.0 (-11)	5.1 (-13)
Zr-95	1.2 (-14)	1.5 (-16)
Zr-97	1.0 (-14)	1.3 (-16)
Nb-95	1.2 (-14)	1.5 (-16)
Mo-99	6.8 (-12)	8.7 (-14)
Tc-99m	2.8 (-11)	3.6 (-13)
Tc-101	5.6 (-11)	7.2 (-13)
Ru-103	6.0 (-15)	7.7 (-17)
Ru-106	7.6 (-16)	9.7 (-18)
Ag-110m	2.4 (-14)	3.1 (-16)
Te-129m	1.0 (-13)	1.3 (-15)
Te-132	4.4 (-12)	5.6 (-14)
I-131	4.4 (-12)	5.6 (-14)
I-132	4.4 (-11)	5.6 (-13)
I-133	3.0 (-11)	3.8 (-13)
I-134	9.3 (-11)	1.2 (-12)
I-135	4.4 (-11)	5.6 (-13)
Cs-134	4.8 (-14)	6.1 (-16)
Cs-136	3.2 (-14)	4.1 (-16)
Cs-137	7.2 (-14)	9.2 (-16)
Cs-138	7.6 (-11)	9.7 (-13)
Ba-139	6.0 (-11)	7.7 (-13)
Ba-140	2.7 (-12)	3.5 (-14)
Ce-141	1.2 (-14)	1.5 (-16)
Ce-143	1.1 (-14)	1.4 (-16)
Ce-144	1.0 (-14)	1.3 (-16)
Pr-143	1.2 (-14)	1.5 (-16)
Nd-147	4.4 (-14)	5.6 (-16)
W-187	1.2 (-12)	1.5 (-14)
Np-239	7.6 (-11)	9.7 (-13)

a. Dilution is calculated assuming an average flow of 17,600 ft^3/s and mixing with one-half of the river flow.

*2.0(-6) = 2.0×10^{-6}

Table 5.2-2

CONCENTRATION FACTORS FOR AQUATIC ORGANISMS

Nuclide	Half-life (days)	Radionuclide Concentration Factors[a, b, c] Fish	Invertebrates	Plants
H-3	4.5 (+3)*	1.0	1.0	1.0
Na-24	6.3 (-1)	1.0 (+2)	2.0 (+2)	5.0 (+2)
P-32	1.4 (+1)	1.0 (+5)	2.0 (+4)	5.0 (+5)
Cr-51	2.8 (+1)	2.0 (+2)	2.0 (+3)	4.0 (+3)
Mn-54	3.0 (+2)	4.0 (+2)	1.4 (+5)	3.5 (+4)
Mn-56	1.1 (-1)	4.0 (+2)	1.4 (+5)	3.5 (+4)
Fe-59	4.6 (+1)	1.0 (+2)	3.2 (+3)	1.0 (+3)
Co-58	7.1 (+1)	2.1 (+1)	1.8 (+2)	6.2 (+3)
Co-60	1.9 (+3)	4.8 (+1)	2.0 (+2)	6.2 (+3)
Ni-65	1.1 (-1)	1.0 (+2)	1.0 (+2)	5.0 (+1)
Zn-65	2.5 (+2)	1.4 (+3)	9.6 (+3)	2.0 (+4)
Zn-69m	5.8 (-1)	1.1 (+1)	5.4 (+2)	2.0 (+4)
Zn-69	4.0 (-2)	0.8	3.9 (+1)	2.0 (+4)
Br-83	1.0 (-1)	4.2 (+2)	3.3 (+2)	5.0 (+1)
Br-84	2.2 (-2)	4.2 (+2)	3.3 (+2)	5.0 (+1)
Br-85	2.1 (-3)	4.2 (+2)	3.3 (+2)	5.0 (+1)
Kr-83m	7.8 (-2)	1.0	1.0	1.0
Kr-85m	1.8 (-1)	1.0	1.0	1.0
Kr-85	3.9 (+3)	1.0	1.0	1.0
Sr-89	5.3 (+1)	1.0 (+1)	4.0 (+3)	3.0 (+3)
Sr-90	1.0 (+4)	3.0 (+1)	4.0 (+3)	3.0 (+3)
Sr-91	4.0 (-1)	1.2 (-1)	3.2 (+3)	3.0 (+3)
Sr-92	1.1 (-1)	3.4 (-2)	2.1 (+3)	3.0 (+3)
Y-90	2.7	2.5 (+1)	1.0 (+3)	5.0 (+3)
Y-91m	3.5 (-2)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Y-91	5.9 (+1)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Y-92	1.5 (-1)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Zr-95	6.6 (+1)	3.3	6.7	1.0 (+3)
Zr-97	7.1 (-1)	3.3	6.7	1.0 (+3)
Nb-95m	3.8	3.0 (+4)	1.0 (+2)	8.0 (+2)
Nb-95	3.5 (+1)	3.0 (+4)	1.0 (+2)	8.0 (+2)
Nb-97	5.0 (-2)	3.0 (+4)	1.0 (+2)	8.0 (+2)
Mo-99	2.8	1.0 (+1)	1.0 (+1)	1.0 (+3)
Tc-99m	2.5 (-1)	1.5 (+1)	5.0	4.0 (+1)
Tc-101	9.9 (-3)	1.5 (+1)	5.0	4.0 (+1)
Ru-103	4.0 (+1)	1.0 (+1)	3.0 (+2)	2.0 (+3)
Ru-106	3.7 (+2)	1.0 (+1)	3.0 (+2)	2.0 (+3)
Rh-103m	4.0 (-2)	1.0 (+1)	3.0 (+2)	2.0 (+2)
Ag-110m	2.5 (-2)	2.0	7.7 (+2)	2.0 (+2)
Te-129m	3.4 (+1)	4.0 (+2)	1.0 (+3)	1.0 (+3)
Te-129	4.8 (-2)	4.0 (+2)	1.0 (+3)	1.0 (+3)
Te-132	3.2 (-1)	4.0 (+2)	1.0 (+3)	1.0 (+3)
I-129	6.2 (+9)	5.0 (+1)	1.0 (+3)	2.0 (+2)
I-131	8.1	4.5 (+1)	1.0 (+3)	2.0 (+2)
I-132	9.4 (-2)	4.3	1.0 (+3)	2.0 (+2)
I-133	8.5 (-1)	2.3 (+1)	1.0 (+3)	2.0 (+2)
I-134	3.6 (-2)	1.7	1.0 (+3)	2.0 (+2)
I-135	2.8 (-1)	1.1 (+1)	1.0 (+3)	2.0 (+2)

Table 5.2-2 (Continued)

CONCENTRATION FACTORS FOR AQUATIC ORGANISMS

Nuclide	Half-life (days)	Radionuclide Concentration Factors[a, b, c] Fish	Invertebrates	Plants
Xe-133m	2.3	1.0	1.0	1.0
Xe-133	5.3	1.0	1.0	1.0
Xe-135m	1.1 (-2)	1.0	1.0	1.0
Xe-135	3.8 (-1)	1.0	1.0	1.0
Cs-134	7.5 (+2)	2.0 (+3)	9.9 (+3)	2.5 (+4)
Cs-136	1.4 (+1)	1.9 (+3)	5.8 (+3)	2.5 (+4)
Cs-137	1.1 (+4)	2.0 (+3)	1.0 (+4)	2.5 (+4)
Cs-138	2.2 (-2)	4.4 (+1)	2.2 (+1)	2.5 (+4)
Ba-139	5.8 (-2)	4.0	2.0 (+2)	5.0 (+2)
Ba-140	1.3 (+1)	4.0	2.0 (+2)	5.0 (+2)
La-140	1.7	2.5 (+1)	1.0 (+3)	5.0 (+3)
Ce-141	3.3 (+1)	2.5 (+1)	1.0 (+3)	4.0 (+3)
Ce-143	1.4	2.5 (+1)	1.0 (+3)	4.0 (+3)
Ce-144	2.8 (+2)	2.5 (+1)	1.0 (+3)	4.0 (+3)
Pr-143	1.4 (+1)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Pr-144	1.2 (-2)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Nd-147	1.1 (+1)	2.5 (+1)	1.0 (+3)	5.0 (+3)
Pm-147	9.6 (+2)	2.5 (+1)	1.0 (+3)	5.0 (+3)
W-187	1.0	1.2 (+3)	1.0 (+1)	1.2 (+3)
Np-239	2.4	1.0 (+1)	4.0 (+2)	3.0 (+2)

*4.5(+3) = 4.5×10^3

a. S. E. Thompson, et al, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms," UCRL-50564, Rev. 1, 1972.
b. D. E. Reichle, et al, "Turnover and Concentration of Radionuclides in Food Chains," Nuclear Safety 11, No. 1 (1970).
c. Personal Communication, S. V. Kaye, Oak Ridge National Laboratory, 1972.

Table 5.2-3

MAXIMUM RADIONUCLIDE CONCENTRATIONS AT THE SITE BOUNDARY (WSW SECTOR)

Nuclide	Air Concentration ($\mu Ci/cm^3$)	Ground Concentration ($\mu Ci/m^2$)
Tritium	5.8 (-11)*	2.8 (+1)
Kr-85m	1.9 (-11)	4.2 (-9)
Kr-85	5.8 (-10)	2.5 (-3)
Kr-87	2.0 (-11)	1.3 (-9)
Kr-88	4.9 (-11)	7.1 (-9)
Rb-88	3.3 (-11)	5.0 (-5)
I-131	1.5 (-14)	8.9 (-5)
I-131[a]	1.6 (-14)	9.6 (-7)
I-132	1.6 (-13)	1.9 (-5)
I-133	1.2 (-13)	1.3 (-4)
I-134	1.7 (-13)	7.5 (-6)
I-135	1.6 (-13)	5.3 (-5)
Xe-131m	3.7 (-19)	5.4 (-7)
Xe-133m	3.2 (-17)	3.0 (-6)
Xe-133	2.9 (-9)	1.5 (-4)
Xe-135m	6.5 (-11)	1.4 (-5)
Xe-135	5.7 (-10)	5.4 (-5)
Xe-138	8.6 (-11)	1.3 (-9)
Cs-135	1.2 (-20)	1.3 (-8)
Cs-138	5.6 (-11)	1.6 (-4)

*5.8(-11) = 5.0 x 10^{-11}

a. Nonelemental forms.

Table 5.2-4

ANNUAL DOSES TO AQUATIC ORGANISMS LIVING IN THE CUMBERLAND RIVER NEAR THE HARTSVILLE NUCLEAR PLANT

Organism	Dose Estimates: Internal (mrad/y) 3-cm	Internal (mrad/y) 30-cm	External (mrad/y)
Plants	4.4 (-1)*	1.5	4.9 (-4)
Invertebrates	7.4 (-1)	1.4	4.9 (-4) suspended
			1.2 (-1) benthic
Fish	8.4 (-3)	1.4 (-2)	4.9 (-4)

$*4.4(-1) = 4.4 \times 10^{-1}$

Table 5.2-5

ANNUAL DOSES TO TERRESTRIAL ORGANISMS LIVING NEAR THE HARTSVILLE NUCLEAR PLANT

	Dose Estimates		
Organism	Internal (mrad/y)	External (mrad/y)	Total (mrad/y)
Cattle (thyroid)	6.6(+2)*	5.4	6.7(+2)
Ducks and muskrats	1.1 (-1)	5.4	5.5
Plants		11	11

*6.6(+2) = 6.6 x 10^2

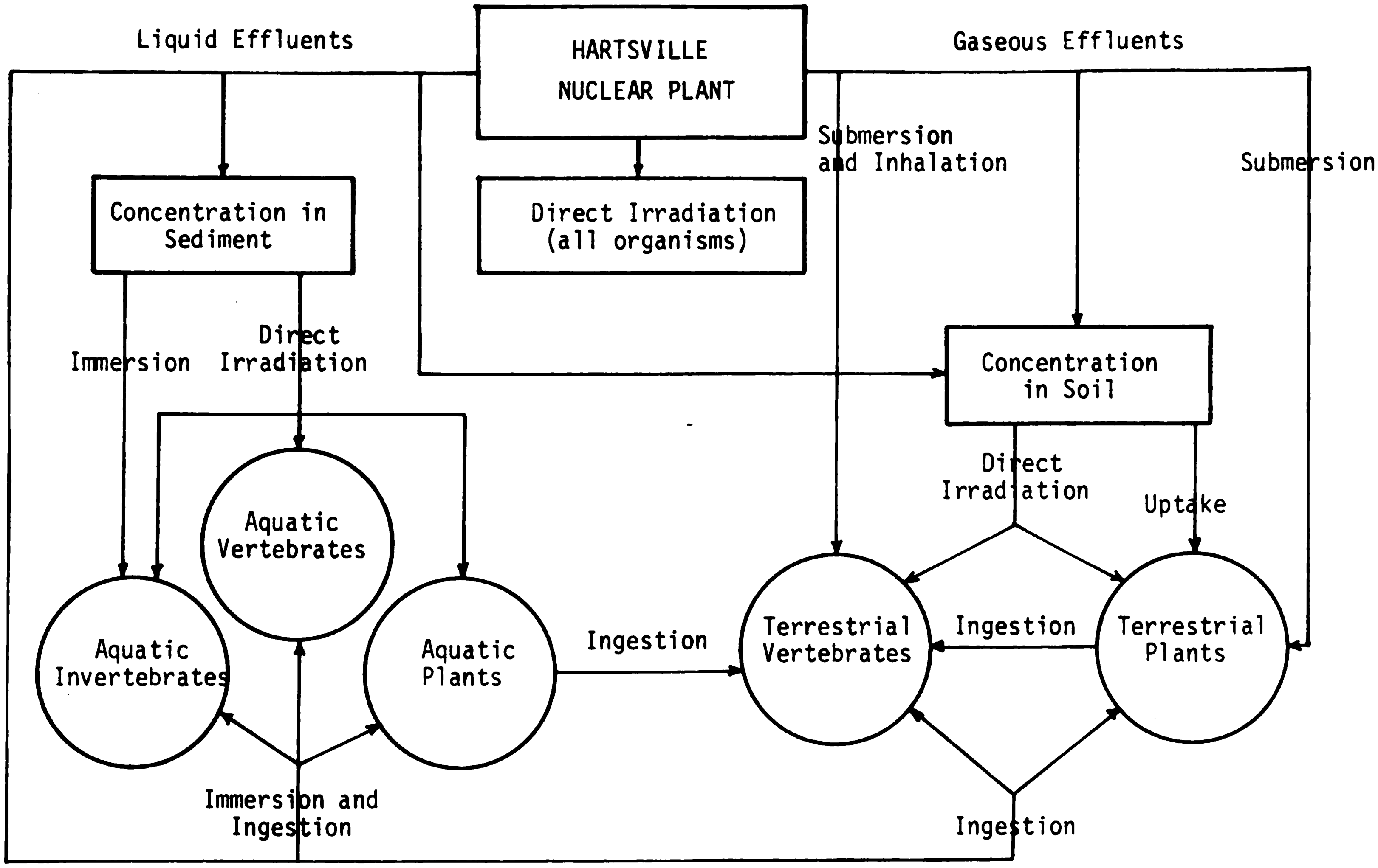

Figure 5.2-1

EXPOSURE PATHWAYS TO ORGANISMS OTHER THAN MAN

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5.3 Radiological Impact on Man

5.3.1 Exposure Pathways - Extensive waste treatment systems included in the Hartsville Nuclear Plant design will assure that the lowest practicable amounts of radioactivity will be released to the environs during normal operation of the plant. However, these releases will result in small exposures to individuals from both external and internal sources. The most significant exposure pathways are diagrammed in Figure 5.3-1.

Radiation exposures from liquid effluents generally arise from recreational activities or diet. External exposures occur as a result of swimming, boating, and fishing in waters containing radioactivity; and persons involved in shoreline activities may be exposed from radionuclides accumulated in sediment. These external doses are proportional to radionuclide concentrations in water and sediment. Internal doses result from ingestion of water, ingestion of fish and other aquatic organisms that contain radionuclides, and ingestion of waterfowl which feed on aquatic organisms. Swimmers receive an internal dose from tritium accumulated in the body as a result of exchange processes.

Individuals exposed to gaseous effluents receive external radiation doses which are dependent upon the duration of exposure and the concentrations of radionuclides in air. An additional source of external exposure, generally of minimal significance, is attributable to radionuclides deposited on the ground. Internal doses result from inhalation, ingestion, and tritium transpiration. The magnitude of these doses is a function of the radionuclide concentrations in air

and the physical and chemical forms of the radioactivity. Internal doses result from ingestion because airborne radionuclides deposited on land areas can be retained on or translocated to edible parts of vegetation. More complex food chains, in which radionuclides ingested by animals are transferred to tissues or animal products subsequently ingested by man, are also potential routes of internal exposure. An important example of such a food chain is the pasture-cow-milk-man pathway. Ingestion doses are functions of radionuclide concentrations on vegetation, transfer coefficients, and dietary habits.

In addition to doses from radioactivity released in liquid and gaseous effluents, external doses result from direct radiation from turbines, steam lines and other equipment in the turbine building and from condensate storage tanks. These doses are functions primarily of the relative geometry between the plant components and the exposed individuals. Radiation exposures also occur during the transportation of radioactive materials to and from the plant. The radiological impact upon the exposed populace is a function of the external radiation levels around the packaging, transportation routes, frequency of shipments, and geometry.

5.3.2 Liquid Effluents - Estimated average annual activities of radionuclides released in liquid effluents are listed in Section 3.5. Data listed in Table 5.3-1 for public and industrial water supply systems are used to calculate dose commitments from the ingestion of Cumberland River water. Populations supplied by these systems in the year 2020 are estimated by multiplying current data by projected county growth factors. Dilution of the radionuclide concentrations

in the Cumberland River is calculated using flow data measured during 1922-71. The plant effluent is assumed to be mixed with one-half of the river flow in the 6.4-mile reach between the nuclear plant and the first public water supply intake. Although natural water turbulence will continue to increase the dispersion downstream, dilution by half the river flow is assumed to be maintained for 30 miles, past which full dilution by the river flow is assumed. Radionuclide concentrations in ground water drawn within one-half mile of the river are assumed to equal the corresponding concentrations at the nearest point in the river. For comparison purposes the doses to a hypothetical individual are estimated assuming ingestion of undiluted liquid effluent.

The portion of the Cumberland River between the river mouth and the headwaters of Old Hickory Reservoir provides an annual commercial fish harvest of 5.4 pounds per acre.[1] The majority of this harvest is comprised of buffalo, carp, and catfish. Sport fish harvests are estimated to be approximately 15 pounds per acre.[2]

Data provided in Table 5.3-2 are used to calculate population doses resulting from recreation activities on or near the Cumberland River. Assumptions regarding use of the river by individuals are given in Appendix I1. Waterfowl taken by resident hunters within Smith, Sumner, Trousdale, and Wilson counties during the 1971-72 hunting season totaled 3,850 birds for an average harvest of 4.6 per hunter.[3]

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The models used to calculate potential doses and the results of these calculations are detailed in Appendix I1. A summary of the estimated doses to individuals from releases of radionuclides in liquid effluents is given in Table 5.3-3.

5.3.3 Gaseous Effluents - Estimated activities of radionuclides released to the atmosphere in gaseous effluents are listed in Section 3.5. Details of the calculations for atmospheric transport and diffusion, ground contamination, and exposure pathway analyses can be found in Appendix I1. All dose calculations are performed using the average annual meteorological joint frequency distribution given in Section 2.6. An estimate of the 2020 population distribution within 50 miles of the Hartsville site is given in Figure 2.2-14. Milk production data within 50 miles of the site for 1972 are given in Table 5.3-4.

Dose estimates for an adult are summarized in Table 5.3-5. The maximum dose to the thyroid of a one-year-old child from the consumption of milk produced by a hypothetical cow grazing on the potential pasture predicted to have the highest average annual iodine concentrations is calculated by TVA methods to be 12 mrem per year. This radiation dose estimate is treated as a special case, and the calculations are discussed in detail in Appendix I2.

5.3.4 Direct Radiation

5.3.4.1 Radiation From Facility - The annual individual and population doses due to direct radiation from the four condensate storage tanks (CST) and the air-scattered N-16 radiation from the four steam turbine systems are summarized in this section. In

calculating annual doses from radioactive material contained in the condensate storage tanks, the collimating (shielding) effects of the terrain and of the buildings surrounding the tanks are considered. Doses at the site boundary and at structures within two miles of the HNP are reported only if these locations are in direct "view" of one or more of the condensate storage tanks. Since the doses computed for N-16 contained in steam turbine systems result from overhead air scattering of N-16 gamma radiation, N-16 doses are calculated at the site boundary for all sectors and at all structures. In computing population doses, persons located beyond two miles from the plant are not considered because of the low doses which are calculated at two miles and because of the further rapid reduction of these low doses with distance.

TVA has determined that there are no hospitals or schools within two miles of the HNP. All persons considered in these calculations are located at private residences (structures). The locations of structures and their spatial relationships to the condensate storage tanks and N-16 sources, the population at each structure, the mathematical models, and the source terms used in these calculations are described in detail in Appendices I3 and I4.

The maximum annual individual doses at the HNP site boundary and at the structures considered in these calculations are listed in Table 5.3-6. These maximum doses occur in different directions from the plant.

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5.3.4.2 Radiation From Transportation of Radioactive Materials

5.3.4.2.1 New Fuel - Radioactive materials which will be shipped to and from the plant during its operational life are described in Section 3.8.

TVA has contracted with the General Electric Company to fabricate the fuel for the Hartsville reactors. The fuel will most likely be manufactured at General Electric's facilities at Wilmington, North Carolina. As stated in Section 3.8, shipment will probably be by truck. Shipment from Wilmington, North Carolina, would cover approximately 600 miles. A possible routing could be as follows:

Wilmington, North Carolina, west on US 76 to I-95 (Florence, South Carolina)

I-95 South to US 378

US 378 West to I-26 (Columbia, South Carolina)

I-26 North to Spartanburg, South Carolina

I-26 North to I-40 (Asheville, North Carolina)

I-40 West to Knoxville, Tennessee

I-40 West to US 231 (Lebanon, Tennessee)

US 231 North to Tennessee 25

Tennessee 25 East to plant site

The levels of radiation that are emitted from unirradiated new fuel assemblies are relatively low. Due to the type of radiation emitted and the self shielding of the fuel itself, no additional gamma or beta shielding is required for shipping packages for new fuel. The radiological impact on the environment is minimal since the new fuel contains no radioactive fission products either gaseous or solid, the fuel has a high melting point, the fuel

is clad with a high-melting-point, high-strength material (Zircaloy), the fuel is in the form of an insoluble solid, and the fuel assemblies are expected to remain stable under all postulated thermal conditions.

Considering the above facts, it is concluded that there are no environmental risks from radiation associated with the normal shipment of new fuel.

The number of shipments of new fuel, packaging description, and shipment weights are given in Section 3.8.

5.3.4.2.2 Spent Fuel - Irradiated fuel will be shipped offsite to a reprocessing plant where usable materials such as fissionable uranium and plutonium will be recovered. The estimated inventory of some fission product activity of the spent fuel originating at the Hartsville plant is given in Table 5.3-8. The major portion of this radioactivity is tightly held within the insoluble, high-melting-point UO_2 pellets. Therefore, there exists no ready mechanism for dispersing any substantial fraction of the total contained radioactivity. Prior to offsite shipment, the fuel will be allowed to radioactively decay for about three to four months. All noble gases with the exception of krypton-85 will have decayed to insignificant levels and iodine-131 will have decayed to low levels. Also, the rate of decay heat generation will have decreased substantially.

The main environmental effect from the normal shipment of spent fuel would be the potential direct radiation dose from the fuel as it passes along its route from the plant site to the reprocessing facility. Dose calculations for normal spent fuel shipment are presented in Appendix D. Assuming a maximum of 45 shipments per year at the maximum permitted level of 10 mrem/h at 6 feet from the nearest

accessible surface,[4] the maximum exposure to an individual residing 100 feet from the center of the transport route would be about .007 mrem/year. The average dose to an individual residing along the route would be about .0004 mrem/year. These doses represent approximately .004 and .0003 percent respectively of the projected average dose resulting from natural background radiation. It is concluded, therefore, that the environmental risk due to normal shipment of spent fuel is insignificant.

TVA as yet has not contracted for reprocessing of spent fuel. At present, there are fuel reprocessing plants in operation or under construction in Morris, Illinois; West Valley, New York; and Barnwell, South Carolina. Shipment could be by truck or rail transport. If it is assumed that the fuel is shipped to Barnwell, South Carolina (currently the nearest facility), the distance covered would be about 410 miles. One possible route would be as follows:

Plant site to Tennessee 25
Tennessee 25 West to US 231
US 231 South to I-24 (Murfreesboro, Tennessee)
I-24 South to I-75 (Chattanooga, Tennessee)
I-75 South to I-20 (Atlanta, Georgia)
I-20 to US 278 (Augusta, Georgia)
US 278 to Barnwell, South Carolina

5.3.4.2.3 Radioactive Waste - The disposal site for radwaste material has not been selected. If it is assumed that the material is shipped to the Nuclear Engineering Company facility at Moorehead, Kentucky, by motor carrier, the distance from the plant site to the facility would be about 260 highway miles. The estimated

routing would be as follows:

Plant site to Tennessee 25

Tennessee 25 West to US 231

US 231 North to US 31E

US 31E North to Kentucky 90 (Glasgow, Kentucky)

Kentucky 90 West to I-65

I-65 North to Bluegrass Parkway (Elizabethtown, Kentucky)

Bluegrass Parkway to US 60 (Versailles, Kentucky)

US 60 East to I-64 (Lexington)

I-64 East to Kentucky 32

Kentucky 32 to burial site

The spent powdered resin, the spent bead resin, sludge, and evaporator bottoms will be placed in 170-cubic-foot containers. The number of shipments are shown in Table 5.3-9. Compacted waste in 55-gallon drums and air filters in boxes will be shipped in closed truck trailers shielded if necessary. More information concerning radwaste is found in Section 3.8.

As stated for the case of spent fuel, the principal environmental effect, albeit small, of radwaste shipment is the potential radiation dose due to direct radiation from the shipment as it moves along the route. Dose calculations are presented in Appendix D. If it is assumed that shipments are made at the highest allowed radiation level, the resulting maximum dose to an individual residing at the edge of the route is about .086 mrem per year and the average is about .005 mrem/year if 542 shipments of evaporator bottoms and spent demineralizer resins are assumed. Other wastes will not contribute significantly to transportation doses. The above dose estimate represents .032 and .002 percent

of the expected natural background dose respectively. Therefore, the expected environmental impact of normal radwaste shipment is not considered significant.

5.3.5 Summary of Annual Radiation Doses - TVA has estimated the radiological impact to regional population groups in the year 2020 from the normal operation of the Hartsville Nuclear Plant. Table 5.3-7 summarizes these population doses (man-rem/y) attributable to the following sources:

1. Exposure pathways related to the Cumberland River.
2. Exposure pathways related to the atmosphere.
3. Direct radiation from the nuclear plant.
4. Direct radiation from the transportation of radioactive materials.

Details of the calculations and additional population doses are located in Appendices D, I1, I2, I3, and I4.

5.3.6 Evaluation of Radiological Impact - Potential individual doses estimated for liquid and gaseous exposure pathways are listed in Table 5.3-3 and Table 5.3-5. The magnitudes of the doses are within the variations in natural background doses received by different individuals because of local differences in the concentrations of terrestrial radioactivity and variations in doses within different types of buildings. Additional variations in the natural background doses within the United States can be attributed to elevation and geomagnetic latitude so that doses to the total body range from approximately 100 mrem to 250 mrem per year.

The annual total body dose from effluent pathways to a population of 1,900,000 persons expected to live within a 50-mile radius of the Hartsville site in the year 2020 is calculated to be approximately 9 man-rem.

By comparison, the same population will receive approximately 270,000[a] man-rem annually as a result of the average natural background dose rate[5] of 140 mrem/y to an individual in the vicinity of the Hartsville site.

TVA concludes that the normal operation of the Hartsville Nuclear Plant will present minimal risk to the health and safety of the public.

[a] 1,900,000 persons x 0.14 rem = 270,000 man-rem.

References for Section 5.3

1. Personal Communication, E. Allen, National Marine Fisheries Service.
2. Personal Communication, W. Turner, Tennessee Game and Fish Commission; various pamphlets in Division of Forestry, Fisheries, and Wildlife Development files.
3. Tennessee Game and Fish Commission.
4. Department of Transportation Regulations, 49 CFR, Section 173.393.
5. Estimates of Ionizing Radiation Doses in the United States, U.S. Environmental Protection Agency Report ORP/CSD 72-1, 1972.

Table 5.3-1

CUMBERLAND RIVER DRINKING WATER SUPPLY INTAKES DOWNSTREAM

FROM THE HARTSVILLE NUCLEAR PLANT

System	County	Location (CRM)	Distance (miles)	Population Served 2020
Hartsville	Trousdale, Tn.	278.6	6.4	4,500
Lebanon	Wilson, Tn.	262.9	22.1	61,400
Gallatin St. Pl.	Sumner, Tn.	243.6	41.4	800
Gallatin	Sumner, Tn.	239.2	45.8	50,400
Camp Boxwell	Sumner, Tn.	236.0	49.0	2,100
ESC Children's Camp	Sumner, Tn.	236.0	49.0	1,600
Old Hickory Ut. Dist.	Davidson, Tn.	219.0	66.0	26,100
Whitehouse Ut. Dist.	Davidson, Tn.	216.5	68.5	25,600
Old Hickory Dam Rec. Area	Davidson, Tn.	216.2	68.8	12,500
Cumberland Water Co.	Davidson, Tn.	207.7	77.3	20,900
Madison Sub. Ut. Dist.	Davidson, Tn.	200.2	84.8	70,400
Nashville	Davidson, Tn.	193.8	91.2	934,700
Harpeth Valley Ut. Dist.	Davidson, Tn.	172.5	112.5	39,400
River Road Ut. Dist.	Cheatham, Tn.	159.9	125.1	1,400
Cheatham Dam Rec. Area	Cheatham, Tn.	148.7	136.3	7,100
Clarksville	Montgomery, Tn.	126.5	158.5	121,000
Dover	Stewart, Tn.	89.5	195.5	2,000
Kentucky State Penit.	Lyon, Ky.	43.7	241.3	2,100
Barkley Dam Rec. Area	Lyon, Ky.	30.6	254.4	3,300

Table 5.3-2

USE OF CUMBERLAND RIVER IN 1972 FOR RECREATIONAL PURPOSES[a]

Reach (CRM)	Above-Water Visits	In Water Visits	Shoreline Visits
0 - 30.6	1.22(5)*	1(3)	1.7(4)
30.6 - 148.7	1.14(6)	1.71(5)	1.79(5)
148.7 - 216	8.51(5)	1.5(4)	1.18(5)
216 - 285	2.89(6)	9.21(5)	5.20(5)
285 - 314	7.0(4)	9.5(4)	2.2(4)

[a]Based on U.S. Army Corps of Engineers Methodology. Plan Formulation and Evaluation Studies Recreation; Technical Report No. 1, Evaluation of Recreation Use Survey Procedures; Technical Report No. 2, Estimating Initial Reservoir Recreation Use, 1969.

*1.22 (5) = 1.22×10^5

Table 5.3-3

SUMMARY OF ANNUAL DOSES TO INDIVIDUALS FROM LIQUID EFFLUENTS[a]

Location/Pathway	Dose Estimates (mrem/y)				
	Total Body	Skin	G.I. Tract	Bone	Thyroid
Hartsville					
Water ingestion	1.5 (-3)*	1.5 (-3)	1.5 (-3)	1.5 (-3)	1.7 (-3)
Effluent Discharge Region					
Shoreline (500 h/y)	3.5 (-6)	4.1 (-6)	3.5 (-6)	3.5 (-6)	3.5 (-6)
Swimming (900 h/y)	5.7 (-4)	5.9 (-4)	5.7 (-4)	5.7 (-4)	5.7 (-4)
Fishing, boating (1,800 h/y)	1.4 (-5)	2.5 (-5)	1.4 (-5)	1.4 (-5)	1.4 (-5)
Fish ingestion (20 kg/y)	2.8 (-5)	2.8 (-5)	5.0 (-5)	4.7 (-5)	8.3 (-5)
Duck ingestion (470 g)[b]	1.2 (-3)	1.2 (-3)	1.7 (-4)	7.9 (-3)	1.3 (-3)

[a] Reference Appendix I1 for details.

[b] Maximum doses per duck ingested.

*1.5 (-3) = 1.5×10^{-3}

Table 5.3-4

ANNUAL MILK PRODUCTION (MILLIONS OF POUNDS)

Sector	Range (miles) 0--10	10--20	20--30	30--40	40--50
N	3.3 (-1)*	5.4 (-1)	1.6	7.4	1.5 (+1)
NNE	3.1 (-1)	5.2 (-1)	6.5	1.1 (+1)	1.2 (+1)
NE	3.7 (-1)	5.2 (-1)	3.5	1.0 (+1)	2.4
ENE	4.2 (-1)	3.9 (-1)	3.4 (-1)	1.9	7.7 (-1)
E	4.2 (-1)	3.9 (-1)	0.0	1.2 (-1)	0.0
ESE	4.5 (-1)	7.5 (-1)	4.8 (-1)	1.6	3.0
SE	4.5 (-1)	1.3	1.5	3.9	6.9
SSE	4.7 (-1)	1.4	2.4	4.2	9.4
S	4.6 (-1)	1.3	2.4	4.0	4.2
SSW	4.4 (-1)	1.3	3.0	9.5	1.3 (+1)
SW	4.5 (-1)	1.2	2.6	8.2	1.3 (+1)
WSW	4.8 (-1)	1.3	2.1	2.7	5.2
W	4.9 (-1)	1.7	3.2	4.7	6.6
WNW	5.2 (-1)	2.1	3.4	7.9	1.2 (+1)
NW	4.8 (-1)	1.9	3.1	5.3	9.0
NNW	2.8 (-1)	7.9 (-1)	1.4	4.1	1.1 (+1)

*3.3 (-1) = 3.3×10^{-1}

Table 5.3-5

SUMMARY OF ANNUAL DOSES TO INDIVIDUALS FROM GASEOUS EFFLUENTS[a]

Location/Pathway (WSW Sector)	X/Q (s/m^3)	Dose Estimates (mrem/y) Total Body	Skin	Thyroid
Site Boundary	9.1 (-6)*			
Submersion		4.8	10	4.8
Ground concentration		4.6 (-2)	5.3 (-2)	4.6 (-2)
Tritium transpiration		4.1 (-2)	4.1 (-2)	4.1 (-2)
Inhalation		7.7 (-2)	7.7 (-2)	9.7 (-1)
Nearest Residence	5.5 (-6)			
Submersion		2.6	5.9	2.6
Ground concentration		2.8 (-2)	3.2 (-2)	2.8 (-2)
Tritium transpiration		2.5 (-2)	2.5 (-2)	2.5 (-2)
Inhalation		4.7 (-2)	4.7 (-2)	5.6 (-1)
Ingestion (leafy veg.)		3.2 (-3)	3.2 (-3)	1.8
Nearest Grazable Land	9.1 (-6)			
Ingestion (milk)		4.9 (-3)	4.9 (-3)	2.8

[a] Reference Appendix I1 for details.
*9.1 (-6) = 9.1 x 10^{-6}

Table 5.3-6

SUMMARY OF ANNUAL DOSES TO INDIVIDUALS FROM DIRECT RADIATION

	Maximum Dose Estimates (mrem/y)			
	Site Boundary		Residence	
Direction	Condensate Storage Tank	N-16 Air Scatter	Condensate Storage Tank	N-16 Air Scatter
ESE	6 (-5)*			
SSE		2.2		
W			9 (-6)	
N				1.5

*6 (-5) = 6 x 10^{-5}

Table 5.3-7

ANNUAL DOSES TO THE POPULATION IN THE VICINITY OF THE HARTSVILLE NUCLEAR PLANT

	Dose Estimates (man-rem/y)				
	Bone	Lung	G. I. Tract	Thyroid	Total Body
Ingestion (water)	9.5 (-1)*	9.5 (-1)	9.6 (-1)	9.8 (-1)	9.5 (-1)
Ingestion (fish)	2.6 (-3)	1.7 (-3)	2.5 (-3)	3.5 (-3)	1.7 (-3)
Ingestion (milk and leafy veg.)[a]	2.3 (-2)	1.8 (-2)	1.7 (-2)	10	1.8 (-2)
Inhalation	3.3 (-1)	8.7 (-1)	3.9 (-1)	3.0	3.9 (-1)

	Skin	Total Body
In-water sports	1.1 (-1)	1.1 (-1)
Above-water sports	2.8 (-5)	1.7 (-5)
Shoreline activities	1.3 (-5)	1.1 (-5)
Submersion in air	2.8 (+1)	8.6
Ground concentration	3.4 (-2)	2.9 (-2)
Direct radiation from facility		6.7 (-2)
Transportation of radioactive matter		7.0 (-2)

[a]Radioiodine only.
*9.5 (-1) = 9.5 x 10^{-1}

Table 5.3-8

SPENT FUEL FISSION PRODUCTS ACTIVITY
Ci/MW_t

Isotope	Half-Life	Burnup: 24,000 MWd/T 90 Day[a]	24,000 MWd/T 160 Day[a]	44,000 MWd/T 90 Day[a]	44,000 MWd/T 160 Day[a]
Noble Gases					
Kr-85	10.8y	415	410	577	567
Xe-131m	12d	2.82	0.05	2.9	0.05
Xe-133	5.3d	0.49	4.9(-5)[b]	0.50	5.0(-5)
Halogens					
I-129	1.6(7)y	1.5(-3)	1.5(-3)	2.7(-3)	2.7(-3)
I-131	8.05d	13.3	0.03	13.8	0.03
Other Fission Products					
Rb-86	18.7d	1.00	0.075	1.63	0.12
Sr-89	50.4d	6,109	2,343	4,850	1,851
Sr-90	28y	3,548	3,534	5,212	5,188
Y-89m	16s	0.61	0.234	0.48	0.18
Y-90	64.2h	3,549	3,533	5,214	5,190
Y-91	59d	10,170	4,469	8,493	3,734
Zr-93	9.5(5)y	0.14	0.14	0.24	0.24
Zr-95	65(d)	17,630	8,361	17,070	8,094
Nb-95m	90h	374	177	362	172
Nb-95	35d	29,270	15,890	28,270	15,370
Tc-99	2.1(5)y	0.72	0.72	1.3	1.3

Table 5.3-8 (Continued)

SPENT FUEL FISSION PRODUCTS ACTIVITY
Ci/MW_t

Isotope	Half-Life	Burnup 24,000 MWd/T 90 Day[a]	24,000 MWd/T 160 Day[a]	44,000 MWd/T 90 Day[a]	44,000 MWd/T 160 Day[a]
Other Fission Products					
Ru-103	39.8d	8,715	2,561	9,537	2,803
Ru-106	368d	20,070	17,580	27,670	24,250
Rh-103m	57m	8,549	2,513	9,355	2,750
Rh-106	30s	20,070	17,580	27,670	24,250
Ag-110m	260d	31.8	26.4	84.8	70.4
Ag-110	24s	0.63	0.53	1.7	1.4
Ag-111	7.5d	0.40	6.3(-4)	0.48	7.5(-4)
Cd-115m	43d	4.24	1.37	4.9	1.6
Sn-119m	250d	1.37	1.11	1.6	1.3
Sn-121m	25y	0.058	0.058	0.12	0.12
Sn-123	125d	32.5	2.23	39.4	27.0
Sn-125	9.4d	0.70	0.005	0.3	0.005
Sb-124	60.2d	125	55.8	155	69.4
Sb-125	2.7y	326	310	525	500
Sb-126	12.5d	0.64	0.04	0.86	0.07
Te-125m	58d	71.2	68.6	118	112
Te-127m	105d	295	189	343	220
Te-127	9.3h	294	188	341	219
Te-129m	33d	209	50.1	210	50.5

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Table 5.3-8 (Continued)

SPENT FUEL FISSION PRODUCTS ACTIVITY
Ci/MW_t

Isotope	Half-Life	Burnup 24,000 MWd/T 90 Day[a]	24,000 MWd/T 160 Day[a]	44,000 MWd/T 90 Day[a]	44,000 MWd/T 160 Day[a]
Other Fission Products					
Te-129	67m	134	32.1	135	32
Cs-134	2.1y	2,740	2,572	6,180	5,801
Cs-136	13d	8.90	0.21	13.5	0.32
Cs-137	30y	5,366	5,343	9,523	9,481
Ba-137m	2.6m	5,017	4,995	8,904	8,865
Ba-140	12.8d	358	8.11	348	7.87
La-140	40.2h	412	9.33	400	9.06
Ce-141	32.5d	7,216	1,616	7,159	1,603
Ce-144	285d	28,840	24,310	26,810	22,600
Pr-143	13.7d	465	13.2	445	12.6
Pr-144	17.3m	28,840	24,310	26,810	24,310
Nd-147	11.1d	60.5	0.77	59.6	0.75
Pm-147	2.7y	8,006	7,611	8,539	8,118
Pm-148m	41d	130	41.1	13.9	43.9
Pm-148	5.4d	9.00	2.82	9.63	3.02
Sm-151	90y	5.61	5.61	7.50	7.49
Eu-154	16y	116	115	284	281
Eu-155	1.8y	2,387	2,218	6,532	6,070
Eu-156	15.2d	10.0	0.41	11.7	0.48
Tb-160	72y	6.85	3.49	15.5	7.90

Table 5.3-8 (Continued)

SPENT FUEL FISSION PRODUCTS ACTIVITY
Ci/MW_t

Isotope	Half-Life	Burnup 24,000 MWd/T 90 Day[a]	24,000 MWd/T 160 Day[a]	44,000 MWd/T 90 Day[a]	44,000 MWd/T 160 Day[a]
Transuranics					
Pu-238	87.4y	52.6	53.0	194	196
Pu-239	2.4(4)y	8.90	8.90	8.95	8.95
Pu-240	6.6(3)y	15.8	1.58	20.3	20.3
Pu-241	14.3y	2.6(3)	2.6(3)	4.1(3)	4.1(3)
Am-241	433y	3.10	3.90	5.30	6.56
Am-243	7.4(3)y	0.36	0.36	2.73	2.73
Cm-242	163d	494	367	1.6(3)	1.2(3)
Cm-243	32y	0.09	0.09	.51	.51

a. Cooling/decay period
b. 4.9×10^{-5}

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Table 5.3-9

Annual Shipments, Package Weights, and Activities from 4-Unit Operation
(80% Capacity Factor)

Type Waste	Number of Shipments per Year	Estimated Package Weight (lbs)	Expected Activity per Package
Reactor Water Cleanup Spent Powdered Resin Spent Bead Type Resin	125*	45,000	66 Ci
Waste Sludge Waste Evaporator Bottoms	417*	45,000	13 Ci
Misc. Dry Solids	16**	300	.075 Ci
Air Filters	1**	250	.05 Ci

* Based on 120 ft^3 radwaste volume per 170 ft^3 container.

** More than one package per shipment.

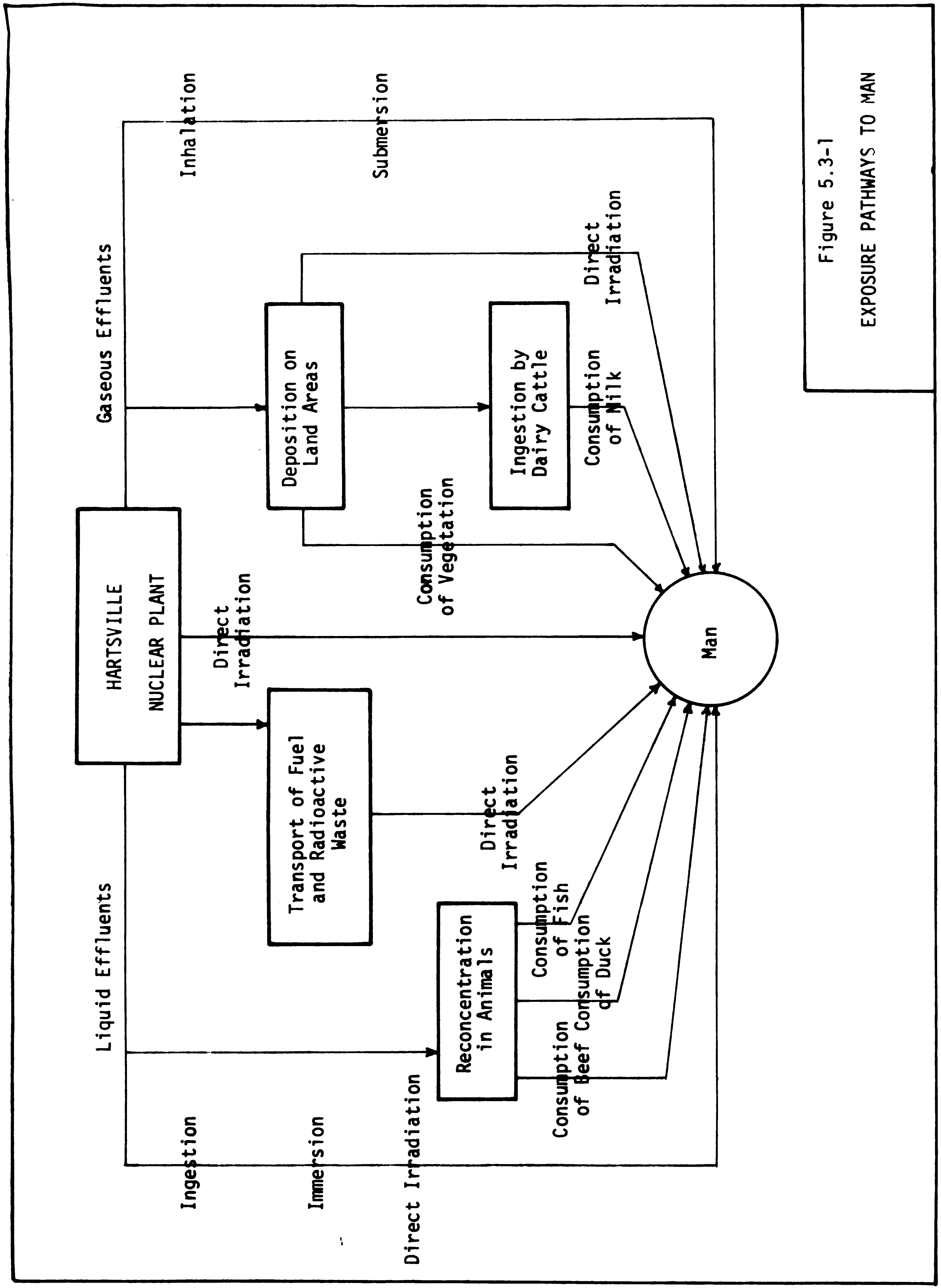

Figure 5.3-1
EXPOSURE PATHWAYS TO MAN

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5.4 Effects of Nonradioactive Chemical Discharges

This section discusses the effects of nonradioactive chemical discharges from the proposed plant to the environment.

The various nonradioactive streams identified which potentially might discharge chemicals to the surface waters or groundwaters are discussed in Section 3.6 along with the treatment of effluents to reduce discharges. Chemicals potentially contained in these streams and their expected concentrations are given in that section. Stream flows, water quality, and other information regarding the natural water supplies which might be affected are discussed in Section 2.5.

All discharges, with the exception of the yard drainage, will be routed through the plant discharge structure discussed in Section 3.4.3. Discharges through this structure will be mixed with the reservoir by the deep water multiport diffuser in the discharge system. This diffuser will be sized to provide a minimum mixing of the discharge with nine equal parts of reservoir water. This dilution factor of ten is based on the minimum discharge of 3,600 cfs from the upstream dam which corresponds to operation of one turbine at Cordell Hull Dam.

Using this basis, expected concentrations of chemicals in the reservoir have been calculated and are included in this section. These concentrations have been calculated using conservative assumptions for chemical usages and expected reservoir conditions.

5.4.1 Cooling Water Blowdown - The blowdown from the main condenser cooling water systems will be the major discharge from the proposed plant. As discussed in Section 3.6, these systems will normally be operated

with a concentration of solids in the system about twice that found in the reservoir and are not expected to exceed 6.6 times the concentration even under the most adverse reservoir flow conditions and the corresponding blowdown holdup periods. Expected maximum concentrations of solids in the discharge from tower blowdown, maximum concentrations in the reservoir after initial jet mixing, typical concentration of solids in Old Hickory reservoir, and applicable water quality criteria and guidelines were shown in Table 3.6-1.

The discharge values are less than the effluent guides in all cases. Some stream guidelines are however, exceeded for concentrations of trace metals in the reservoir after mixing, but all such cases occur only when the initial river concentration before addition of the discharge already exceeded the stream guides.

It can be seen from Table 3.6-1 that upon mixing with the reservoir, Tennessee state guidelines would be exceeded for total phosphate, total iron, manganese, aluminum, and potassium. Although these guidelines are exceeded, the increase in concentration is not expected to have a significant environmental impact.

There are no planned uses of any materials that would result in normal discharge of "added" trace metals to the aquatic environment.

In regard to the concentrations of trace metals calculated, no distinction has been made of element state or form. For conservatism, it is considered that all forms are available to the biota. In actuality, this is not true as discriminatory limits determined by the state or form of the element as presented to an organism.

Resulting concentrations of all discharged elements after mixing in the reservoir are within the natural fluctuations in the reservoir.

As discussed in Section 3.6.1, it is expected that chemical biocides will be used in the main condenser cooling water system and other raw cooling water systems to control slime and algae growth and for the control of asiatic clams. Chlorine in the form of sodium hypochlorite will be fed as a biocide to all of the systems using raw water. Acrolein, an unsaturated aldehyde, has been shown to be particularly effective as a biocide for the control of asiatic clams and its use could be required for this purpose. If used, it would be fed to the small cooling systems such as the ESW and raw cooling water systems. Chlorine would be fed to these systems 60 minutes each day to maintain a residual of about 0.5 mg/l within the systems. Acrolein, if used, would be fed for 30 minutes once daily to maintain a residual of about 0.3 mg/l within the systems.

Chlorine residual in the discharge will be monitored, to assure that applicable limits are met.

The acrolein fed to the raw cooling water system would be diluted by a factor of about 10 upon mixing with the main condenser cooling water assuming that all of the raw cooling water systems were treated with acrolein simultaneously. Taking no credit for the natural acrolein demand of the raw water or of the systems, this would result in a concentration of less than 0.03 mg/l in condenser cooling water systems and less than 0.003 mg/l at the edge of the mixing zone in the reservoir as a result of the CCW blowdown after discharge through the diffuser. The 96-hour TLM for fathead minnows is reported[1] to 0.06 mg/l; for juvenile minnows the 48-hour TLM[2] was 0.24 mg/l. The maximum concentration from dilution alone would be less than 5 percent of the lowest 96-hour TLM.

The maximum doses discussed above would only result if blowdown were discharged during periods of acroleination. Blowdown will be shut off during feed periods and will not be reinstated until some time after feed periods have terminated. The concentration in the cooling system will therefore be much less than even those discussed above due to the natural acrolein demand of the system and the scrubbing action of the tower fill. In addition, the average natural acrolein demand of the Old Hickory reservoir water is about 0.06 mg/l in one hour. It is expected that this demand would consume the acrolein residual in the condenser circulating water system and the concentration in the discharge to the reservoir would be zero. Also, since acrolein is volatile, any residual acrolein reaching the towers would be partially scrubbed out of the cooling water on its first pass through the cooling tower fill. Thus, there should be no significant adverse effects on the reservoir from discharge of biocides from these systems.

Blowdown from the closed cycle ESW system will be discharged along with the blowdown from the main condenser cooling water system. In general, the discharges from the ESW through blowdown are of the same nature as those discussed for the main condenser cooling water system.

On the average, the concentration of solids in the ESW blowdown will be below the concentration in the condenser circulating water system. The relatively small volume of the ESW blowdown will not affect concentrations in the reservoir to any significant degree but would on the average reduce the concentration of the main condenser cooling system blowdown.

Since the ESW system is a closed-cycle system, its blowdown can be shut off when biocide treatment is being used. Upon resumption of the ESW blowdown, an additional reduction in concentration will occur

due to the approximately 30 to 1 dilution obtained when the blowdown from this system is mixed with the condenser cooling water blowdown. In addition, the demand of the condenser cooling water blowdown will add assurance that no residual biocide is discharged.

5.4.2 Cooling Tower Drift - Droplets of water carried out of the tower as drift will contain the same concentrations of solids, etc., discussed above. Some of these droplets will evaporate leaving the solids as a dust-like residue to be dispersed to the environment. Large droplets not evaporated deposit on the immediate area around the tower. Studies by Stewart[3] and Hosler, et al[4] indicate that the majority of drift particles fall out within 2,000 feet of the cooling tower under normal conditions. Approximately 484 pounds of solids per day at full operation will be carried out of the towers as drift. These solids will be those taken from the reservoir.

Current state of the art is insufficient to accurately predict the deposition patterns of the drift and assess its impacts. However, natural draft cooling towers have been used at TVA's Paradise Steam Plant for several years. An observation program at Paradise has not identified any significant impacts on the surrounding environment resulting from drift from the towers. After discussing the possible environmental effects of solids from drift for fresh water cooling towers with other investigators,[5] TVA has determined that there will be no significant adverse environmental impacts due to the deposition of solids in the form of drift from the operation of the Hartsville cooling towers.

5.4.3 Makeup Water Treatment Plant Wastes - There will be two waste streams from the water treatment plant as discussed in Sections 3.6.3 and 3.6.4. The sludge from the flocculation and filter process will be dewatered and disposed of as solid waste by burial in an approved landfill. Burial is a commonly accepted method of disposal for this type waste and is used by municipal and industrial plants and environmental impacts from this method of disposal would be minimal.

The neutralized spent regenerants from the makeup demineralizer will be mixed with the condenser cooling water and discharged via the condenser cooling water blowdown as discussed previously. The discharge concentrations shown in Table 3.6-2 show that the daily concentrations of these minerals discharged from the plant would be small compared to the natural concentrations present in the reservoir.

5.4.4 Auxiliary Boiler Blowdown - As discussed in Section 3.6.5, the blowdown from the auxiliary boilers will contain approximately a 0.3 mg/l concentration of ammonia and a very small amount of solids. It is expected that by routing this blowdown to the condenser cooling water systems cooling towers, the ammonia concentration would be removed due to the aeration effects of the towers. The contribution to discharge concentrations due to eventual discharge of this blowdown via the condenser cooling water system would be minimal.

Even if the blowdown were to be discharged directly via the condenser cooling tower blowdown, the dilution of greater than 3,000 would reduce the ammonia concentration to less than 0.1 mg/l which is far below any identified harmful concentrations. In any case, it is felt that due to the quality and size, this blowdown stream would have no detectable impact upon the environment.

5.4.5 Various Plant Systems - As discussed in Section 3.6.6 and Section 3.6.8, various systems within the plant are treated chemically for corrosion control and other reasons. The potential any of these systems would have for discharging pollutants to the environment would be either through leakage or being drained for maintenance. In either case, the waste from these systems would be contained inside the building sumps or other storage facilities. These wastes would then be treated in the radwaste system by filtration, demineralization, or evaporation. After treatment, the treated water would be recycled if possible and the waste disposed of as solidified waste. If the water is not suitable for recycle, it would be discharged only after it had been analytically tested to ensure it did not contain any harmful substances. It is not expected that any discharge of pollutants would occur from these sources.

5.4.6 Discharges from Transformers and Electrical Equipment - Oil and lubricants used in transformers and electrical equipment were discussed in Section 3.6.7. The plant design is such that in the event any of these compounds leaked from their equipment or storage facilities, they would still be contained. Leakage inside the buildings would flow to the building sump where it would be contained and recovered for reclamation or disposal. Leakage of materials in the switchyard or storage areas will be contained within diked areas and basins provided for this where they could be recovered.

In the event these materials were to escape from the sumps and basins, they would flow to the yard drainage pond. The yard drainage pond is designed so that the oil could not escape from the pond, but would be retained for recovery.

References for Section 5.4

1. Butler, P. A., 1965 "Effects of Herbicides on Estuarine Fauna," Proceedings of Southern Week Conference, 18:576-580.

2. Oberton, A.C.E. and V. T. Stack. 1957 "Biochemical Oxygen Demand of Organic Chemicals," Sewage Industrial Wastes 29 (11): 1267-1272.

3. Stewart, R. E. Atmospheric Diffusion of Particulate Matter Released from an Elevated Continuous Source. Journal of Applied Meteorology. 7 (3):425-432, June 1968.

4. Hosler, C. L., J. Pena, and R. Pena. Determination of Salt Deposition Rates from Drift from Evaporative Cooling Towers. Department of Meteorology, The Pennsylvania State University. May 1972. 46 p.

5. Telephone conversations on May 14, 1974, between W. C. Colbaugh, Air Quality Branch, TVA and James E. Carson, Argonne National Laboratory, Chicago, Illinois, and A. Roffman, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania.

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5.5 Environmental Effects of Sanitary Wastes and Other Discharges

5.5.1 Effects from Sanitary Wastes - The treatment the sanitary wastes will receive was described in section 3.7.1. As was described, the effluent from this treatment plant will be a chlorinated stream meeting the applicable requirements of the Tennessee Pollution Control Board. The expected total discharge of sanitary waste pollutants from each plant is as follows:

	Pounds/day	Δ Concentration in Blowdown
Suspended Solids	16.80	0.06 ppm
Dissolved Solids	29.90	0.10 ppm
BOD, 5 Day 20°C.	2.61	
Phosphate (Soluble)	1.07	8.70 ppb
Chlorine	0.49	1.60 ppb

As can be seen, the concentrations of these materials are insignificant when compared with the natural levels of those present in the reservoir (section 2.5). Both plants will be operated to insure that any untreated wastes will not be discharged to the reservoir. It is therefore expected that there will be no significant adverse effects on the environment because of the discharge from the sanitary waste treatment plant.

5.5.2 Effects from Chemical Discharges - Other sources of chemical wastes which will potentially discharge to the environment would be (1) treated water from the chemical drain tank (section 3.7.2), (2) vaporized detergent wastes (section 3.5),

(3) leakage to floor drains from various auxiliary systems within the plant (section 3.7.5), and (4) drainage from the yards (section 3.7.6).

Treated water from the chemical drain tank will be distilled water since it will have been treated via the evaporator. Therefore only infrequently will any distillate from this system be discharged since it will be suitable for reuse within the plant as makeup to the demineralized water systems or any other system. If the situation were such as to dictate such a release, the water will have been analyzed. If the analysis shows the pollutant levels to be within acceptable limits the water would be discharged. Adherence to these practices will minimize the potential for impacts resulting from this system.

Detergent wastes will be evaporated and not discharged to the waterways. Although the detergent wastes constitute a small portion of the plant discharges, the detergents present are potentially environmentally detrimental to the quality of water in the Old Hickory Reservoir. By evaporating these wastes, a small amount of water vapor will be discharged to the air, but the solids will be disposed as solid radwaste--thereby minimizing the environmental impact. Adverse effects are not expected from the small discharge of water vapor.

Leakage from various systems to floor drains will be treated in the radwaste system. Release of these liquids would only occur after filtration, evaporation, and demineralization. After treatment, the effluents would normally be recycled but, in the infrequent

event of release, they would be analyzed before discharge to prevent the release of pollutants in any level which would produce a significant adverse effect on the environment or exceed applicable standards.

Chemicals within the yard area will generally be contained in the immediate area of their use by dikes, basins, etc., and reclaimed. In the unlikely event the material were to escape the containment, it would flow to the yard drainage pond where it will be detected by routine surveillance. It would be contained in the pond until reclaimed or adequately treated. No additives will be routinely discharged via the yard drainage system.

5.5.3 Effects from Solid Waste Disposal - Nonradioactive solid wastes from the plant will be disposed of in an approved landfill as described in section 3.7.4. This is a common method practiced by industry and municipalities and has been shown to be environmentally acceptable.

5.5.4 Gaseous Emissions - Emissions from the auxiliary steam generators are shown in section 3.7.5 as well as the maximum expected ambient pollutant surface concentrations from these sources and the applicable ambient standards. It is evident that these emissions from these sources will result in a small fraction of the applicable guides and will, therefore, be of negligible environmental impact. Diesel generators, when operated, produce gaseous emissions. However, the diesel generators are operated so infrequently that the impact is insignificant.

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5.6 Effects of operation and maintenance of transmission lines - No significant adverse environmental impact is expected to occur during normal operation of the 500-kV transmission lines. During inclement weather and unusual atmospheric conditions a light humming may be audible directly under the 500-kV lines, but this noise should rarely be heard off the right of way. Transmission lines can, under certain conditions, cause mild static charges to develop on some types of fencing and other ungrounded objects under the lines.

For the transmission line rights of way, property owners retain all mineral rights to their land and may use the land for whatever purposes desired so long as such uses do not conflict with the terms of the easement. In most instances the existing land uses, particularly agricultural uses, may continue. However, buildings, signboards, stored personal property, or other obstructions which create fire hazards and/or interfere with the operation and maintenance of the line may not be located on the rights of way.

Transmission line maintenance requires that vegetation be controlled so it will not interfere with the safe and reliable operation of the line nor impede restoration of service when outages occur. Growth of vegetation will be controlled by mechanical or hand cutting, replacement planting, and limited use of herbicides. In wooded areas brush mowing (bushhogging) will be combined with hand- or power-saw felling of larger timber. For heavier stands, dozer-blade clearing will be employed, and a brush rake will be used to windrow the felled brush along the edge of the right of way. Vegetation will not be

removed where there is no danger of trees interfering with line operation such as in ravines and deep hollows.

5.6.1 The "Edge Effect"[1,2], Wildlife Benefits and Impacts - Operation of the proposed lines should have no significant impact on wildlife, but maintenance activities will cause periodic changes in animal communities by removal of woody vegetation every 3 to 5 years. These maintenance clearing activities will cause changes in bird, mammal, reptile, and amphibian populations. TVA is presently in the process of establishing research projects which will enable quantification of the changes and shifts in populations due to power line construction and maintenance activities.

Early stages of plant succession on cleared rights of way, particularly the first 6 to 8 years, are the most productive for many wildlife food and cover plants. In addition, the low herbaceous plant growth supports insects which provide the high protein content necessary in the diet of many young vertebrates (game and nongame).

Power line rights of way have potential as habitat for certain species because of the "edge effect" that results where low herbaceous and woody plant growth meets the forest or where adjacent cropland and weedy or "brushy" rights of way merge. The zone or edge where two communities meet and overlap commonly contains species from both communities in addition to other species which are indigenous to the edge area. In many cases the number and density of some species is greater in the edge than in the vegetation communities adjacent to it.

A common wildlife management practice in large sections of unbroken forest land is to develop relatively small, evenly spaced clearings.

Rationale for this practice is to provide the diversity in the forest environment necessary to attract greater numbers of species. Power line rights of way essentially create linear forest openings. The sunlight penetrating the forest edge through the rights of way stimulates understory growth adjacent to the power line. Periodic power line maintenance then perpetuates these habitat conditions. Specific management practices geared toward wildlife production can significantly enhance the wildlife potential already present along transmission lines. TVA attempts to implement such management practices jointly with the agency controlling public lands crossed and with the landowner on private lands when consistent with his own land use desires.

Rights of way in wooded areas are planted to grasses or low-growing vegetation except along the outer edges where taller growing plants such as autumn olive may be used. Maintenance is then geared to the continuation of improved habitat conditions for selected wildlife species.

TVA, in cooperation with the Tennessee Game and Fish Commission, now named the Tennessee Wildlife Resources Agency, has published a booklet for distribution to landowners within the service area describing practices they can employ to benefit various wildlife species on rights of way.[3]

Old Hickory Reservoir (Cumberland River) which seasonally attracts substantial numbers of waterfowl, is traversed by the proposed transmission line corridors. It is expected that some waterfowl will collide with the lines resulting in their injury or death. However, TVA does not anticipate the frequency of collisions to result in a significant impact.

5.6.2 Chemical Maintenance of Right of Way - A special problem on the proposed rights of way is the growth of vegetation because of the relatively long growing season in central Tennessee. It will be controlled by mechanical or hand cutting, replacement planting, and the limited application of herbicides. During the fiscal year ending June 30, 1971, a transition was made in TVA's right of way maintenance program from essentially complete herbicidal control to primarily mechanical maintenance. Chemical maintenance is now limited to those areas which are both remote and inaccessible. For the transmission line corridors connecting the Hartsville Nuclear Plant, the need for chemicals in the maintenance program for these corridors is not anticipated.

However, when herbicides are used, their application is carefully controlled to ensure on-target placement and avoid drift off the right of way or contamination of watercourses. Watercourses are identified by ground or air reconnaissance prior to spraying, and no chemicals are applied within 100 feet of these areas. The herbicides used for aerial application are Tandex and Tordon 101; for hand applications Tordon 10K pellets are used, all of which are approved for this use by the Federal Working Group on Pest Management (FWG on PM). From transmission line right of way inspections, TVA determines each year where chemical control of brush is to be used, the chemicals to be employed, and the method and rate of application. The entire annual program is then submitted to the FWG on PM for their review.

In addition to information about program objectives, chemicals used, and mode of application, the program annual report summarized

precautions taken by TVA in applying the chemicals and specifies areas of the environment that are to be avoided or treated with caution. Field observations have revealed no significant adverse environmental effects from the use of chemicals in the right of way maintenance program. In addition, formal studies are planned to quantitatively document these observations.

TVA employees responsible for right of way maintenance work closely with TVA wildlife biologists and foresters. The combined expertise of these TVA employees and other TVA specialists ensures that biologically sound and economically feasible recommendations are made to improve wildlife habitat on the rights of way.

A detailed report of TVA's program for chemical treatment of transmission line rights of way as submitted to the Federal Working Group for calendar year 1974 can be found in Appendix L2.

5.6.3 Multiple Use of Rights of Way - As a general rule, where transmission line rights of way cross wooded areas, TVA is willing to perform the necessary clearing or invest as its part of a cooperative arrangement an amount which approximates the average cost to clear or later reclear the area as dictated by maintenance requirements. TVA negotiates with county agents, state, and Federal park commissions, soil conservation agencies, sportsmen groups, and other interested agencies that propose compatible uses for wooded land within easement areas that will meet the goals of the interested parties. Under such an arrangement, forest development interests can be implemented which allow growing of small trees such as Christmas trees and nursery stock.

Also, buckwheat, Korean and Kobe Lespedeza, and other low-growing grasses and seed crops can be planted which are beneficial to game and non-game species.

It is recognized that many additional multiple right of way uses can be identified. Agricultural uses other than the growing of timber may be continued. The easement area may be fenced and cross-fenced. Roads and driveways may be installed provided fills do not interfere with proper clearances of the transmission line, and utilities such as water lines, telephone lines, electrical distribution lines, sewer lines and gas lines may be installed. Stock ponds or lakes may be built provided tower foundations are not jeopardized. Lawns, flower or vegetable gardens, and other domestic uses may continue. The landowners involved may also establish playgrounds, athletic fields, golf courses, parks, picnic areas, hiking trails and horseback riding trails. In short, all multiple uses are permitted under the terms of TVA's easement other than those which would interfere with the safe operation and maintenance of the transmission line.

5.6.4 Ozone - Under some conditions, ozone may be produced in small amounts from corona discharges (ionization of the air) in the operation of transmission lines and substations, particularly at the higher voltages. Such corona discharges can result from abrasions, foreign particles, or sharp points on electrical conductors and electrical equipment.

Extensive field tests to detect ozone in the vicinity of 765-kV lines were conducted by the Battelle Memorial Institute under a variety of meteorological conditions. From these tests, it was concluded that

no significant adverse effects on vegetation, animals, or humans are to be expected from levels of ozone that may be produced in this operation of transmission facilities at voltages up to 765 kv.

In view of the design and construction standards employed by TVA in building its transmission facilities, corona discharges are minimal or nonexistent. In this connection TVA specifications require that transmission line hardware and electric equipment for operation at 500,000 volts be factory-tested to assure corona-free performance up to maximum operating voltage levels. Accordingly any ozone which could possibly be generated by the proposed transmission lines (500-kV nominal voltage) would be environmentally inconsequential and harmless to vegetation, animals, and humans.

A list of reference material and technical reports on the characteristics, sources, and effects of ozone can be found in Appendix L3.

5.6.5 Compatibility With Communications Equipment - High-voltage power lines operating in close proximity to telephone and signalling equipment may produce undesirable effects on the communication circuit through inductive coupling. However, it is TVA's normal practice to send transmission line vicinity maps to railroad and telephone companies having tracks or communication lines in the general area of proposed power lines for the purpose of making inductive coordination studies. If corrective action is indicated, the problem is jointly studied and any required changes will be mutually resolved. This procedure will be followed for the transmission line connections to Hartsville Nuclear

Plant. For the proposed routes, no interference problems with communication facilities are anticipated.

5.6.6 Access for Right of Way Maintenance - Existing woods roads, farm roads, county and state highways will provide adequate access for maintenance operations, and no special maintenance access roads will be required for the transmission line connections to the Hartsville plant.

5.6.7 Impacts on Aviation - Tall towers normally are required to accommodate long spans associated with major river crossings or to provide electrical clearance over unusual topographic features or man-made objects. When these towers exceed a height of 200 feet above local terrain or invade upon air traffic patterns, a permit must be obtained from the Federal Aviation Administration prior to construction.

The proposed transmission line corridors will cross the Cumberland River in the vicinity of the Hartsville Nuclear Plant. Transmission structures in excess of 200 feet in height are not anticipated for these relatively short river crossing spans; however, should final design dictate the use of tall towers, filing for FAA permits will be made. Appropriate markings and/or warning lights will be installed on these towers.

REFERENCES FOR SECTION 5.6

1. Leopold, Aldo, <u>Game Management</u>: Charles Scribners Sons, New York, 1933, p. 131.

2. Odum, E. P., <u>Fundamentals of Ecology</u>: W. B. Saunders Company, 1959, pp. 278-281.

3. Tennessee Valley Authority, Division of Forestry, Fisheries, and Wildlife Development and Tennessee Game and Fish Commission, <u>What Can You Do To Benefit Wildlife on Your Land?</u>, 1969.

5.7 Adverse Effects which Cannot be Avoided

The construction and operation of the proposed Hartsville Nuclear Plant will result in some impacts to the environment which cannot be avoided. These impacts include air and water pollution, damage to life systems, alteration of land features and use, and effects on the social and economic structure of the area. However, efforts made to mitigate these impacts will reduce effects to insignificant levels.

Baseline data on the preexisting appearance, quality, productivity, and usage of the proposed site have been discussed in Chapter 2. Discussion and evaluation of such expected impact on the environment resulting from construction and operation of the proposed facility are given in Chapters 4 and 5. This section will summarize the adverse impacts which cannot be avoided due to construction and operation of the project and the steps taken to mitigate these effects.

5.7.1 Water Pollution - Some unavoidable impacts to waters of the Old Hickory Reservoir will occur during construction of the plant. These include some siltation as a result of grading, excavating, and dredging; discharge of small amounts of chemicals used in cleaning equipment; and discharge of the sewage treatment plant effluent.

These impacts will be minimized by the following means:

- If dredging is accomplished by a suction dredge, the spoil material will be deposited in an upland fill area to avoid excessive siltation of the reservoir.

· Berms, diversion dikes, check dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, special drains, and other control devices will be used to control surface drainage and erosion during grading operations.

· Soil and rock from excavation work will be used as fill or stored in compacted mounds and seeded if necessary to prevent wind and rain erosion.

· Spoil material from excavation work will be wasted in preselected areas as fill, graded to conform to surrounding landscape, covered with topsoil, seeded, and mulched to avoid erosion.

· Impacts due to chemical discharges to the reservoir will be minimized by the use of holding ponds, neutralization, and other treatment which may be required to reduce concentrations substantially below harmful levels.

· Extended aeration treatment of sanitary wastes and chlorination of effluent will be provided during construction.

Operation of the Hartsville plant will result in small amounts of heat, chemical, sanitary, and radioactive liquid wastes being discharged into the Old Hickory Reservoir. Mitigation of possible related effects will be accomplished as follows:

· Closed-cycle natural draft cooling towers will minimize the quantity of waste heat discharged to the receiving waters.

· A diffuser will rapidly mix the heated cooling tower blowdown with unheated reservoir water.

· Secondary treatment of the sanitary wastes with provision for effluent chlorination will be provided for the permanent plant.

• Radioactive waste liquids will be treated by evaporation and the distillate will be recycled to the extent practicable.

As indicated, adequate treatment of liquid effluents is provided before being discharged to ensure that all applicable standards are met and that the quantities and concentrations released will be small enough to ensure that any adverse environmental effects are minimal and localized. Water, aquatic life, and life systems will be carefully monitored to detect possible adverse environmental effects, although some adverse effects may be undetectable.

5.7.2 Air Pollution - The construction of this facility will result in a minimal short duration impact to the atmosphere from selected burning of cleared brush and trash.

There will be some radioactive gaseous wastes released to the atmosphere and some negligible additions of nonradioactive gaseous emissions to the atmosphere. Some local accumulation of dissolved solids may take place on surfaces exposed to the drift from the cooling towers. In addition, large quantities of waste heat and moisture from the cooling tower plumes may result in some alteration of the local atmospheric conditions. During adverse weather conditions, this increased moisture content may cause local fogging and icing. However, such occurrences resulting from the operation of the cooling towers should be infrequent. To the extent that local fogging and icing occur, it represents an unavoidable adverse environmental effect.

Mitigation of the probable related effects from these discharges to the atmosphere is accomplished as follows:

- Brush and trash burning will be done in accordance with applicable state regulations and as atmospheric conditions permit.
- Radioactive gaseous waste will be treated as required to reduce radiological doses to levels as low as practicable.
- Natural draft hyperbolic cooling towers disperse heat and moisture to the atmosphere about 500 feet above the ground.
- Cooling tower design will keep water losses due to drift from the cooling towers to a minimum.

No significant adverse environmental effects should be caused by these releases to the atmosphere.

5.7.3 Impact on Land Use - The construction and operation of the Hartsville Nuclear Plant will result in a change in land use of approximately 1,940 acres from predominantly farming and pasture to industrial use. In addition, right of way easements will be obtained on approximately 5,400 acres of land. Approximately 40 per cent of this acreage is forested and will be removed from this land use category. This accounts for about 0.12 per cent of the forested land in the counties traversed by these corridors.

The land use adjustments are not judged to be significant adverse environmental impacts.

5.7.4 Damage to Life Systems - When the auxiliary cooling water and cooling tower makeup water pass through the traveling screens, fish larvae and plankton will be drawn into the water intake. These will be

destroyed in passing through the closed cooling system. To the extent that the plankton and larval fish drawn into the water intakes serve as a food source for aquatic life and the basis for harvestable fish production, their destruction is an adverse effect which cannot be avoided. However, the relatively small quantity of water required and proper design and location of the water intake facilities will minimize these effects.

5.7.5 Accidental Releases of Radioactive Materials - The facility is being designed and constructed and will be operated in accordance with all applicable regulations in order that the health and safety of the public will be safeguarded.

Significant accidental releases of radioactive products at the plant or during transportation of radioactive materials are very improbable. Should such a release occur, implementation of the radiological emergency plans would mitigate the potential risk to the public.

5.7.6 Socioeconomic Effects - The construction and operation of the plant will have an economic and social impact. Although the plant will provide an economic stimulus to the region, stress on present institutions, such as schools and housing facilities, will unavoidably result in placing a greater demand on both the public and private sectors to provide the necessary community services.

5.7.7 Other Effects - Construction of the plant will necessitate the disturbance of archaeological sites present on the plant site.

These will, however, be investigated in order to record or preserve to the extent necessary the significant value of their contents to minimize the impact.

Construction of the plant will necessitate relocation of approximately 50 people. Assistance will be provided, as appropriate, to mitigate the effects associated with the relocation.

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5.8 Resources Committed

The construction and operation of the Hartsville plant will entail the commitment, both reversible and irreversible, of certain resources. In addition, this section assesses the relationship between short-term use and the maintenance and enhancement of long-term productivity. In general, the short-term uses of land, water, and other resources will result in no significant effect on the long-term productivity of the region. Likewise, irreversible commitments of resources are not expected to significantly curtail potential uses of the environment.

5.8.1 Fuel Resources - Operation of the reactor will require a commitment of approximately 304,000 pounds of uranium for each reactor core. The annual commitment of uranium will be about one-third of the above amount per unit. A small quantity of fuel oil will be required for the operation of auxiliary boilers and testing of diesel generators. To the extent that these fuels are consumed and not subject to recycle for other uses, this represents an irreversible and irretrievable commitment of resources. Fuel commitments for plant construction are discussed in section 4.4.

5.8.2 Land and Water Resources

5.8.2.1 Fish and Wildlife - As discussed in Section 5.1, operation of the Hartsville plant will result in losses of aquatic biota due to entrainment and impingement. This represents an irretrievable commitment. However, it is not expected that these losses will be large enough to have any significant effect on the overall, long term productivity of the reservoir.

A commitment of approximately 350 acres of terrestrial habitat will be made for the plant. It is possible that a portion of this land will be irretrievably committed, depending on the method of final disposition selected for the plant after the end of plant life. As discussed in Section 2.7, the acreage in question has been extensively farmed and the wildlife population is extremely low so that the effects on wildlife of such a commitment will be insignificant. It is possible the removal from production of land currently being farmed will actually increase wildlife populations.

Additionally, it is estimated that about 5,400 acres of land will be utilized for transmission line rights of way. In areas where the land traversed is forested, there will be a habitat change which will result in the commitment of some wildlife production. It is not expected that such a commitment would be significant since most species would move to suitable habitat or adapt to the altered habitat. There is also expected to be some offsetting benefits since the altered habitat also has the potential for attracting new wildlife species and establishing a new ecological community.

5.8.2.2 Agricultural - The total plant site will cover about 1,940 acres. A topographic layout of the site is given in Section 2.1 and the site's agricultural land use and production for 1973 is given in Sections 2.2.2 and 2.7.1.

The entire site area, most of which is being utilized for agriculture, will be removed from agricultural production for the life of the plant. This represents an irretrievable commitment of the agricultural products which could have been produced during the period

of plant construction and operation. The total area in agricultural production in Smith and Trousdale Counties is 109,129 acres. The Hartsville site has about 1,750 acres currently in agricultural production, which is only 1.6% of the total for the 2-county area. There are 26,191 acres in the 2-county area made up of the three classes of land described by the U. S. Department of Agriculture as having the widest range of uses and the highest suitability for crop production.

A majority of the land on the site could be made available for other uses, including agriculture, after plant decommissioning, and the lost production is not expected to constitute a significant adverse impact on either the short-term or long-term productivity of the region. Since the exact method of decommissioning has not been definitely determined, it must be assumed that the land directly under the reactor systems buildings is irretrievably committed.

The erection and maintenance of electrical transmission facilities will preclude the production of certain products during the life of the transmission lines; however, the transmission lines will not preclude land use for standard agricultural purposes and agricultural production on the transmission rights of way may actually increase due to TVA reseeding practices discussed previously.

Approximately 15,000 cords of pulpwood and 4,850,000 bd.ft. of saw timber will be removed from the forested portions of the transmission corridors. Timber to be removed will be marketed where feasible. Productivity of the forested area traversed is estimated to be 45 cu.ft. per acre per year. This represents a committment of 0.19 percent of the annual productivity of the twelve counties traversed by the corridors.

5.8.2.3 Potential Recreational - Plant construction and operation should have little or no adverse impact on existing or potential recreation. The low density recreation activities which occur in the immediate region should continue essentially unaffected. A length of shoreline will be removed from any potential for recreational use, however, this commitment is not irreversible since the shoreline could be made available for non-industrial uses following plant life. As discussed in section 5.8.2.1, no significant adverse irreversible effects on the fish or wildlife populations of the area are expected. Therefore, no long-term adverse impact on recreational fishing or hunting is anticipated. Construction and operation of the plant will not significantly impact water available for recreation either by streamflow alteration, consumptive use, or contamination of water. TVA expects that future recreation in the immediate region will remain primarily rural in nature and remain essentially unaffected by the plant.

The visitors' center discussed in Section 2.1 will provide some new recreational and educational facilities to the area for at least the life of the plant.

5.8.2.4 Potential Industrial - Existing industrial locations nearest the plant site are located in the city of Hartsville. The construction and operation of the plant will not adversely affect these industries.

The land to be utilized for the plant is not now used for industrial purposes. Projections do not call for any industrial growth in the area which would conflict with plant construction and operation.

It is not expected that the plant would adversely affect industrial growth in the area for any reason.

5.8.3 Other Resources - At present, no mineral resources are being worked in the area; however, several private companies have explored for zinc ore in areas slightly beyond the exclusion radius of the plant. In an effort to evaluate ore potential, which might be jeopardized by the plant, TVA combined with Cominco American, owner of mineral rights beneath the property, to drill two deep holes into the assumed ore bearing horizons. Neither hole indicated mineral concentrations which could be considered economically feasible, nor were other resources such as natural gas or oil encountered. It is therefore concluded that no mineral resources are being committed within the plant site.

5.8.4 Short-Term Uses Versus Long-Term Productivity - The construction and operation of the Hartsville plant will result in short-term uses of the environment for the production of electrical power. The adverse effects of these short-term uses will be minimal and are expected to have no long-term impacts on the environment and its productivity. The cumulative effect of the plant will be a localized shift of land usage to meet the demand for power.

Most of the short-term uses of the site itself will result in no significant adverse effect on the long-term productivity of the land directly affected or of the general area. As discussed in section 4.1, construction will be carried out in such a manner as to minimize impacts on long-term productivity. In addition, the atmosphere, and, to a much lesser extent, the Cumberland River will be used for the dissipation of

waste heat. Any thermal discharges to the river will be within applicable standards and should have no appreciable effect on either the short-term or the long-term productivity of the receiving waters. Radioactive discharges will be negligible. Neither radioactive nor chemical discharges will hamper other short-term uses or alter the long-term productivity of the environment.

Environment monitoring programs will include the sampling and analysis of the air, water, aquatic life, and food web near the facility. This will provide a baseline inventory for detecting and evaluating any specific parameters of environmental impacts which might lead to long-term effects, in order that consideration of corrective action can be undertaken on a timely basis.

The construction and operation of the Hartsville Nuclear Plant will be carried out in such a manner as to minimize as much as practical adverse environmental impacts in order to pass on to future generations an environment with its potential productivity essentially unimpaired.

Where transmission lines traverse forested areas, timber production is lost for the life of the line. However, the forest productivity lost is only .19% of the annual total for the 12 county area affected. Furthermore, there are offseting benefits such as habitat diversity, increased acreages of cleared land available for agricultural uses, and other compatible uses of the corridors.

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5.9 Decommissioning and Dismantling

No specific plan for decommissioning the plant has been developed. The long-term commitment of land and environmental consequences of decommissioning cannot be adequately determined until a decommissioning plan has been selected. Near the end of the plant's useful life, TVA will prepare a proposed decommissioning plan for submittal to AEC for review. The plan will comply with regulations then in effect. Decommissioning will not commence until authorized by AEC. To date, experience with decommissioning of civilian nuclear power reactors is limited to six facilities which have been shut down or dismantled: Hallam Nuclear Power Facility, Carolina Virginia Tube Reactor (CVTR), Boiling Nuclear Superheater (BONUS) Power Station, Pathfinder Reactor, Piqua Reactor, and the Elk River Reactor.

There are several alternatives which can be and have been used in decommissioning of reactors: (1) Remove the fuel (possibly followed by decontamination procedures); seal and cap the pipes; and establish an exclusion area around the facility. The Piqua decommissioning operation was typical of this approach. (2) In addition to the steps outlined in (1), remove the superstructure and encase in concrete all radioactive portions which remain above ground. The Hallam decommissioning operation was of this type. (3) Remove the fuel, all superstructure, the reactor vessel and all contaminated equipment and facilities, and finally fill in cavities with clean rubble topped with earth to grade level. This last procedure is being applied in decommissioning the Elk River Reactor. Alternative decommissioning procedures (1) and (2) would require long-term surveillance of the reactor site. After a final check to assure

that all reactor-produced radioactivity has been removed, alternative (3) would not require any subsequent surveillance. Possible effects of erosion or flooding will be included in these considerations.

Present estimated costs of decommissioning at the lowest level are about $5,000,000, plus an annual maintenance cost of about $500,000. Complete dismantling and restoration of the site are estimated to cost about $125,000,000.

The design of the plant will be such that none of the decommissioning alternatives are precluded, and the variety of choice will be maintained until the end of useful plant life.

The degree of dismantlement will be determined by an economic and environmental study which takes into account the value of the land and salvage values as well as other relevant factors. In any event, the decommissioning operation will be controlled by rules and regulations to protect the health and safety of the public that are in effect at the time.

6.1

6. EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

This chapter describes procedures and programs that will assess environmental impacts due to construction and operation of the Hartsville Nuclear Plant. The material is divided into preoperational and operational monitoring programs. Data obtained for impact assessment will be divided into three categories:

Baseline (preconstruction)--Data collected will describe the radiological and nonradiological, terrestrial and aquatic conditions that exist at the plant site and its surroundings prior to the commencement of construction activities and/or operation of the Hartsville plant. These data serve as the base for subsequent evaluation of impacts due to construction, as well as compliance with institutional regulations on plant discharges during plant operation stage.

Construction--Monitoring programs will focus on those parameters which demonstrate effects, or lack thereof, of those activities concerned with site preparation and plant construction. Emphasis will be placed on, but not limited to, detection of nonradiological changes in terrestrial environs, surface water, and limnological characteristics at the site.

Operation--Monitoring programs will be designed to ensure that operation of the plant will conform to institutional compliance regulations and radiological and nonradiological technical specifications and to assess effects of plant operation.

The monitoring program will be periodically reviewed and various elements may then be added to the program or deleted as appropriate.

6.1 Preoperational Environmental Programs

6.1.1 Surface Waters

Old Hickory Reservoir, Dixon Creek, Corley Branch and the unnamed creek to the east of Corley Branch, along with several small intermittent streams and small farm ponds, will be affected by construction and subsequent operation of the Hartsville Nuclear Plant (figure 6.1-1). Consequently, a broad spectrum of parameters are being examined to obtain baseline data on the site and its surroundings. During construction monitoring, sampling parameters will be reduced but frequency of sampling will be increased in order to concentrate on detailing the impacts of construction activities.

A program for quality control shall include unknown samples, blinds, spiked samples, reference samples, and at least 10 percent actual replication.

6.1.1.1 Physical and Chemical Parameters

The baseline data collection program is being conducted for TVA under a two-year contract with Tennessee Technological University. Construction monitoring commitments will be maintained thereafter by TVA.

6.1.1.1.1 Baseline Monitoring

Water quality surveys are to include, but not be limited to, the following parameters according to the Environmental Protection Agency[1] publication on biological surveys at heated discharge locations: temperature, pH, conductivity, alkalinity, solids (total, dissolved, and suspended), dissolved oxygen, five-day 20° C. BOD, COD, nitrogen series (nitrate, nitrite, organic, and ammonia), phosphorus (soluble and total), copper, nickel, zinc, chromium, coliforms (total and fecal), and acrolein and chlorine demand (one year only on quarterly basis). Additional parameters (for example, B, Na, SO_4, Mn, Cd, and Pb) will be monitored if necessary.

The sampling schedule will be monthly for the first 12-month period and quarterly (by calendar year) for the remainder of the preconstruction stage. Sampling stations are listed in Table 6.1-1. All samples will be analyzed in accordance with TVA standard laboratory procedures.[2]

Data will be maintained on the Environmental Protection Agency's STORET data recall system for retrieval and analysis. Statistical routines for preconstruction monitoring will include, but not be limited to, calculation of values for maxima, minima, means, and standard deviation for each station on a yearly basis. An analysis of variance can be made to determine if there are significant differences between stations and depths for each water quality parameter.

6.1.1.1.2 Construction Monitoring

Water quality surveys for construction monitoring will be reduced from baseline monitoring to include the following: pH, temperature, dissolved oxygen, conductivity, coliforms, solids, turbidity, nutrients (nitrogen and phosphorus), and BOD. These parameters should reflect changes due to construction.

Survey frequency will be quarterly for the duration of the construction program. Sampling stations will be reduced to CRM 292.4, 284.5, and 278.6. Additionally, peripheral monitoring at construction zones will be conducted routinely. Peripheral monitoring will include about five stations on tributary streams in the immediate area. These stations will be sampled for one year prior to onset of construction activities during periods of high rainfall to determine natural turbidity. Once construction begins, the program sampling

will be flexible and permit sampling during periods of high rainfall and major phases of construction. Aerial photographs (color) to assess the magnitude and location of construction effects will be taken.

6.1.1.2 Ecological Parameters

6.1.1.2.1 Fish Program

Fish baseline collection began in September 1973. Information gathered to date is incorporated in this report (Section 2.7 and Appendix F1). The following is a summary of the sampling program:

Gill net samples are being collected at two stations above and below the plant site (CRM 284 and 286). Each sample consists of ten, 100 x 8 ft., 1-1/2-inch bar mesh gill nets fished four consecutive nights each sample period. Sample periods are April, May, June, August, November, and January. During April, May, and June another station located in the backwater of Dixon Creek is sampled to identify spawning areas.

Hoop net and other sampling techniques, such as electrofishing, will also be used at the above stations at certain times of the year, as appropriate.

Rotenone samples are collected in Dixon Creek and Corley Branch embayments during late August or early September. Stream surveys using chemicals, electroshockers and/or seines were made in Dixon Creek and Wilburn Creek in June and September 1973.

Larval fish samples are being collected weekly April through July in Dixon Creek and in the main river channel at CRM 285.5.

A creel census will be made in the plant site area during March through October.

Locations of these sample stations are shown in Figure 6.1-2.

Construction activities potentially present two main types of aquatic impacts: the long-term commitments of acreages of water and substrate, particularly embayments and overbank areas, and the short-term increases in turbidity and localized siltation.

Acreages of aquatic habitat lost due to construction of intake and discharge facilities, barge-docking facility, and earthfills will be documented. Baseline information will permit quantification and evaluation of this effect. Since construction effects are expected to be too transient to elicit measurable responses from fish populations, routine monitoring of fish is not planned. Sampling activities during the construction phase will be directed at updating baseline information for use during operation assessment. Physical, chemical, and other biotic measurements during this phase will permit indirect evaluation of impacts on fish.

6.1.1.2.2 Limnological (Non-Fish) Program

Baseline Monitoring--The baseline data collection program will be conducted for TVA by Tennessee Technological University.

The primary effect of plant construction effluents, if any, will be on the aquatic community downstream from each point of discharge. Therefore, primary emphasis on biological changes will be placed on the benthic forms that spend most of their life cycle in one location on the river bottom. Principal macroinvertebrate populations in the area are being determined and enumerated. In addition, an artifical substrate sampling device is being considered to more completely assess the biological impact. If natural populations of *Corbicula* are too low, test organisms may be used provided sampling is done with replacement.

Periphyton substrates have been placed in the stream and examined periodically (usually 14-17 days) during the spring and summer months for colonization rates, autotrophic-heterotrophic indices, and percentage composition.

Surveys are being conducted quarterly during the fall (October-December) and winter (January-March). Since non-molluscan macroinvertebrate populations may have large seasonal variations (life cycles, emergence times, etc.), all benthic sampling during the spring (April-June) and summer (July-September) will be on a monthly basis.

Sampling stations correspond approximately to the same river miles as those for sampling water quality. Benthic samplings are along at least three horizontal cross sections at CRM 292.4, 285.0, and 284.5. Stations are to be permanently buoyed or some form of shore marking (by river mile) established to ensure return to the same location on each survey (see Tables 6.1-2 and 6.1-3).

Phytoplankton and zooplankton are to be sampled for only the initial year of preconstruction monitoring to give a basis for estimation of entrainment impact. Should additional sampling of the planktonic community become necessary, stations will be added. Zooplankton analysis will include identification of the species and biomass per unit area and volume. Phytoplankton analysis will include percentage composition of diatoms, green algae, and blue-green algae. Benthic fauna (ponar and artificial substrates) analysis will include identification of the species where practical and biomass per unit area (per unit in case of artificial substrates).

Data analysis will include calculation of mean and standard deviation by sampling station and season for each parameter.

Construction Monitoring--The purpose of construction monitoring is to ensure that adequate control measures are taken during construction to minimize any adverse effects in the aquatic environment. The most probable impact of construction will be caused by siltation, spillage, and sewage effluents.

Aquatic biological sampling parameters will be maintained as previously described. However, phytoplankton will be added to help assess the effect of siltation.

Survey frequency will be monthly during the months of April to September. Frequency will be reduced to quarterly between October and March. Periphyton substrates will be set and sampled as previously described. As in water quality monitoring, sampling locations will be reduced to three stations (CRM 278.6, 284.5, and 292.4). Biological surveys must, however, be conducted in conjunction with the water quality surveys, i.e., same day, same general time, and in areas surrounding the station location.

Data analysis shall include, but not be limited to, a comparison between upstream and downstream stations to demonstrate effects of construction. Analysis should include calculation of mean and standard deviation by station location and season for each parameter.

6.1.2 Ground Water

6.1.2.1 Physical and Chemical Parameters

A system of nine ground-water observation wells was installed at the site in 1972, in which water levels have been observed on a periodic basis. Background radioactivity content of the ground water will be determined on samples from these wells. Additionally, from each of the nine observation wells a quarterly grab sample will be taken for chemical

analysis. These samples are to be analyzed for the following parameters: temperature, pH, conductivity, alkalinity, solids (total, dissolved, and suspended), chemical oxygen demand, nitrogen series (nitrate plus nitrite, organic and ammonia), phosphorus (soluble and total), coliforms (total and fecal), copper, nickel, zinc, chromium, boron, sodium, sulfate, manganese, cadmium, and lead.

About the time the plant goes into operation, a pump will be installed in a well near the plant to provide daily samples which will be composited and analyzed monthly for radioactivity content. The pump-sampled well may be one of the existing observation wells or it may be one drilled especially for the purpose. Grab samples will be obtained periodically from the other wells for radiochemical analysis.

6.1.2.2 Models

No attempt to model the ground-water system will be made for the Hartsville site. No satisfactory model is available to handle the complex areal variations of ground-water systems such as this.

6.1.3 Air

This section describes the proposed environmental meteorological monitoring program for the Hartsville Nuclear Plant. Program objectives for the preconstruction and construction phases are presented, along with the rationale for selecting the meteorological monitoring sites, instrumenting the tower facilities, and collecting and evaluating the data.

6.1.3.1 Preconstruction Phase

6.1.3.1.1 Objectives

The principal objective of the environmental meteorological monitoring program during the preconstruction phase is to establish an adequate data base from which preliminary assessments can be made of the air quality impacts on the local environment from plant operations. These impacts should fall into five categories--all identified with cooling tower operation. They include visible plume configuration, fogging and icing, drift deposition, local weather modification, and if feasible, local ecological effects.

6.1.3.1.2 Data Sources

The collection of meteorological data for identifying the representative plant site meteorological conditions began at the temporary meteorological facility on February 1, 1973. The rationale for the siting and instrumenting of the facility was based on TVA's extensive monitoring experience and compliance requirements of Regulatory Guide 1.23. The facility is located on the proposed site for one of the reactor buildings. It includes a 150-foot steel tower with wind direction, wind speed, and temperature measured at the 33-foot (10-meter) and 150-foot levels. The two temperature values provide the required delta-t, or stability,

measurements. These data are used primarily to identify the low-level dispersion conditions in the plant site area. Outside, or offsite, data sources were required to provide an adequate data base for the preliminary assessment of the expected environmental impact from cooling tower operations. The TVA statistical model for estimating cooling tower plume lengths required temperature and dew point profile data from the National Weather Service Upper Air Section near Nashville, Tennessee, as well as concurrent wind data from the Hartsville temporary onsite meteorological facility. Specific plant operational data for the blowdown discharge as well as river temperature data were required to assess the potential river fogging.

6.1.3.1.3 Impact Assessment

The onsite and offsite meteorological data were used with the TVA model to obtain estimates of the frequency of occurrence of plume lengths from the natural-draft cooling towers within the 16-compass point sectors around the plant site. The resultant fogging and icing was then assessed in terms of potential impact on the local air, road, and water (river) traffic. Another statistical model was used to assess the potential fogging attributable to blowdown discharge into the Cumberland River.

An evaluation will be made of the environmental impact of drift deposition in the vicinity of the natural-draft cooling towers. An attempt will be made to identify the impact to drift in the form of solids as related to effects on soil, plants, and animals. (See Section 5.4 of this report for further discussion of cooling tower drift.) The specific materials to be considered will consist primarily of those added to the cooling water during plant operations.

Also, consideration will be given to the effects of cooling tower operation on the local meteorology, involving the assessment of increased river fogging and icing from blowdown discharge.

6.1.3.2 Construction Phase

6.1.3.2.1 Objectives

The objective of the environmental meteorological monitoring program during the construction phase is to establish an upgraded data collection program for obtaining more detailed and representative measurements of the expected onsite meteorological conditions. From such data, more definitive assessments of the environmental impact from plant operations can be determined. The same five principal categories of impact considerations, i.e., visible plume configuration, fogging and icing, drift deposition, local weather modification, local ecological effects, will be further evaluated and upgraded.

6.1.3.2.2 Data Sources

Following the issuance of the plant construction permit or limited work authorization, the installation of the permanent meteorological facility will proceed and the data collection program should begin four to six months later. The facility will consist of a 110-meter steel tower on or near the plant site. Instrumentation will probably include wind direction and wind speed at 10 and 110 meters, temperature at 10, 60, and 110 meters, dew point at 1, 10, and 110 meters, turbulence indicators at 10 and 110 meters, and precipitation, solar radiation, and atmospheric pressure and fog intensity at 1 meter.

6.1.3.2.3 Impact Assessment

The new onsite meteorological facility will provide an improved data base to upgrade the environmental impact assessment developed from the

limited onsite and offsite data during preconstruction phase. The height of the new tower will provide a direct 100-meter temperature difference readout in direct compliance with the Regulatory Guide 1.23 requirements. The data will also provide a more realistic (less conservative) identification of the low-level stability conditions than were obtained from the 150-foot tower facility during the preconstruction phase. A new prototype dew point system will provide direct dew point difference data from near surface to 110 meters. This higher tower, with the elevated wind, temperature, and dew point measurements, will provide an improved data base for developing more definitive assessments of the principal meteorological elements involved in the environmental impact evaluations. During the construction phase, close liaison and coordination will be maintained with TVA branches involved in various ecological studies in the plant site area. Particular emphasis will be given to establishing criteria, based on meteorological considerations, for identifying major areas for siting biological, soil, and other types of field network samplers. If preliminary studies indicate that drift deposition may be a problem, special sampling will be conducted. Continuing surveillance will be maintained over the occurrence of natural fogging in the plant site area with emphasis on the potential intensification and resultant impact of fogging and icing on the Cumberland River from blowdown discharge. Consideration will be given to augmenting temperature and dew point measurements in the plant site area with monitors strategically sited in principal sectors where special ecological surveillance programs will be conducted.

6.1.3.3 Models

Four mathematical models are used to estimate atmospheric dispersion factors (χ/Q values) for gaseous effluents from the Hartsville Nuclear Plants. Two models are used in estimating dispersion during postulated reactor accidents and the remaining models are used to estimate dispersion of radionuclides released in gaseous effluents during routine operation. Calculations are based on one year of meteorological data (February 1, 1973 - January 31, 1974) for each of the sixteen 22-1/2-degree sectors.

6.1.3.3.1 Reactor Accidents--Two mathematical models are used to estimate χ/Q values for postulated reactor accidents--one for the 8-hour averaging periods (0-8 hours) and the other for the 16-hour (8-24 hours), 72-hour (1-4 days), and 624-hour (4-30 days) averaging periods. Calculations with the two models utilize hourly values of wind direction, wind speed, and atmospheric stability. Average χ/Q values for each wind direction and time period are applied in estimating doses from postulated accident releases presented in Section 7.1 of this report. The centerline building wake equation[3] for χ/Q is used for the 8-hour time periods:

$$\frac{\chi}{Q} = \frac{1}{\pi \Sigma_y \Sigma_z \bar{u}} \tag{1}$$

where

$$\Sigma_y = \left(\sigma_y^2 + \frac{cA}{\pi}\right)^{1/2} \tag{2}$$

and

$$\Sigma_z = \left(\sigma_z^2 + \frac{cA}{\pi}\right)^{1/2} \tag{3}$$

where:

χ/Q = centerline atmospheric dispersion factor, s/m^3,

π = 3.1416,

Σ_y = horizontal standard deviation of the plume modified for the effect of building wake dilution, m,

Σ_z = vertical standard deviation of the plume modified for the effect of building wake dilution, m,

σ_y = Pasquill horizontal standard deviation of the plume, m,

σ_z = Pasquill vertical standard deviation of the plume, m,

$\bar{u}$ = mean horizontal wind speed, m/s,

c = an empirical constant used in defining the magnitude of the building wake,

A = building area, m^2.

The following restriction of $\Sigma_y\Sigma_z$ is observed for the 8-hour period:

$$\Sigma_y\Sigma_z \leq 3\,\sigma_y\sigma_z,$$

The sector average building wake equation[3,4] for χ/Q values is used for the averaging periods greater than eight hours:

$$\frac{\chi}{Q} = \sqrt{\frac{2}{\pi}} \quad \frac{1}{\Sigma_z u \Theta x}, \qquad (4)$$

where

Θ = sector width, radians,

x = downwind distance, m.

The following restriction on Σ_z is observed in calculating χ/Q values for time periods in excess of eight hours:

$$\Sigma_z \leq 1.73\sigma_z$$

For this model (equation 3), it is assumed that sufficient time elapses to allow the plume meandering to spread the effluent uniformly across the 22-1/2-degree downwind sector.

6.1.3.3.2 Routine Operation

Building wake atmospheric dispersion models described in Appendices I1 and I2 are used to calculate average ground-level air and surface concentrations of radionuclides released through vents located near the roofs of various plant buildings. These models are applicable for routine releases over long time periods, and the use of average annual meteorological data is believed to be reasonable for the dispersion calculations. For intermittent releases during periods of favorable meteorological dispersion conditions, the use of average annual meteorological data should be conservative for these calculations.

The atmospheric dispersion model described in Appendix I1 is based on the assumption that all effluent released from the building vents of the Hartsville Nuclear Plant is entrained in the turbulent wake downwind from the plant buildings. TVA staff believe that during low wind speed conditions, plant effluent is not entrained in the turbulent wake of the plant buildings and that the full effect of an elevated release is realized. This subject (elevated releases from building vents during low wind speeds) is discussed in detail in Appendix I2.

A full-scale field study "Evaluation of Roof Vent and Reactor Building Release Dispersion" is being developed under auspices of the Atomic Industrial Forum, Inc., and should be implemented within the near future. The purpose of this study is to compile data from field testing of reactor and turbine building roof vent effluent releases at selected sites to verify the existence of an elevated release from these sources with no subsequent downwash effects except under certain atmospheric conditions.

6.1.4 Land

6.1.4.1 Geology and Soils

The attached drawings (Figure 6.1-3, 6.1-4, and 6.1-5) indicate the extent of foundation investigations carried out at the site.

Since the start of investigations, some 47,000 linear feet of core drillings and 23,000 linear feet of percussion drilling have been completed. All percussion holes and some core holes have been logged by the contractor. In addition, caliper and sonic logs have been completed. TVA has run single point resistivity logs. In addition, one 36-inch diameter calyx hole was completed to four feet below the meta-bentonite (T-3) horizon. T-3 samples from the core, and in situ samples are being laboratory tested. These cores have been inspected by geologists from the U.S. Geological Survey and Vanderbilt University.

In order to ensure against deep solution features, four core holes each in excess of 800 feet in depth have been drilled to the top of the Knox Formation in the presently proposed plant site. In addition, TVA joined with a company holding mineral rights to drill two holes into the potential zinc ore zone of the Knox. Each hole was in excess of 1,500 feet in depth. Neither indicated minable deposits beneath the exclusion area, and there are no outcrops of the Knox ore body within the area of the exclusion radius. For additional information, see Section 2.4. For ground water evaluations, see Sections 2.2.4.2, 2.5.2.1. 2.5.2.2, and 2.5.2.3.

6.1.4.2 Land Use and Demographic Surveys

6.1.4.2.1 General Land Use

Land use information was obtained primarily through aerial photography taken in May 1973. This was supplemented by the Recreation Map for Old Hickory Reservoir, the General Plan, Hartsville, Tennessee, and the General Plan, Smith County, Tennessee. In addition, field trips to the site and vicinity provided additional insight.

Land use and cover changes are likely to occur in the general vicinity of the site. For the purpose of this discussion, we propose to consider a corridor consisting of the area from Hartsville to Carthage and north of the Cumberland River to a distance of approximately five miles. These changes will be assessed using aerial photography and/or field surveys.

6.1.4.2.2 Terrestrial Flora and Fauna

The preoperational terrestrial flora and faunal programs are designed to: (1) provide baseline ecological information of the project area; (2) provide information regarding site environs for project planning; (3) provide the basis for assessing effects of construction activities; and (4) establish a reference framework for assessing effects of plant operation.

The material presented in Section 2.7 is based on preliminary surveys of the Hartsville site which were conducted in summer 1972. The baseline studies were begun in March 1974 and will be completed in March 1975.

Baseline or preconstruction investigations begun in late March 1974 included wildflower floristic inventories and reptile and amphibian searches in various habitats. These two phases of the overall program will be continued through the summer of 1974. A complete site vegetation study including a quantitative plant ecological study and timber inventory will be completed in fall 1974. The herptofauna study will be completed by the end of summer 1974 while reptile and amphibian searches will continue until early March 1975.

No rare and endangered reptiles and amphibians nor rare or unusual plants have been identified to date. The bird survey commenced in late May-June 1974 and will be completed by the first of September 1974. Cursory field checks of various habitat types to date have indicated that no rare or endangered avian species inhabit the site. Spring investigations showed that migrating waterfowl use the Dixon Creek bottoms rather intensively when the agricultural land is flooded. Several pairs of breeding wood ducks were seen along Dixon Island.

Mammal studies will be conducted in fall 1974 and be completed by January 1975. Initial investigations of habitat types indicate that no unusual species inhabit the area.

In summary, the designated timetable will allow all vegetation studies to be completed by the end of November 1974, bird studies by September 1974, mammal studies by January 1975, and reptile and amphibian studies by March 1975.

The sampling program is described in the remaining portions of this section. The basic methods and sampling periodicity are given in table 6.1-4 and figure 6.1-5. Definition of parameters is given in table 6.1-5. Information obtained during previous surveys and preliminary baseline information were used to predict effects on terrestrial environs and in selecting and evaluating plant subsystems.

Construction activities will result in primary terrestrial effects such as modification and alteration of habitat by blasting, drilling, excavating, and clearing. At the Hartsville site specific examples are the development of access corridors (roads, railroads, and service transmission lines), clearing and excavation (intake and discharge areas, holding ponds, cooling towers, and other buildings), noise and vibrations from construction equipment, exhaust emissions, atmospheric particulates, fuel leaks and spills, mud, and activity of men and machines. Secondary effects at the site will include the more subtle changes in land use. For example, land previously used for agricultural pursuits and not directly affected by construction could gradually revert to higher successional stages. Construction effects will be assessed by collecting and analyzing data from permanent plots on the project site. Offsite effects will be assessed primarily by aerial photography.

<u>Vegetation</u>--Permanent one-fifth-acre plots will be established on the plant site environs. A vegetation-type map will be prepared and cover types located on aerial photographs and maps. The purpose of the baseline study which begins the monitoring program is to provide information on species frequency, distribution, density, and percent cover of higher plants in the area including the status of any local important species.

Relocatable plots will be established in all habitat types. Pole, sawtimber, and reproduction data will be collected from forest plots. Four 1/100-acre subplots will be located at cardinal points around the periphery of each 1/5-acre plot. In each subplot, all tree stems between one and five inches diameter breast height (DBH) will be recorded and classified as "shrub stratum." Percent cover will be recorded for each shrub stratum species according to the following code:

1 - less than 5 percent

2 - 5 to 25 percent

3 - 26 to 50 percent

4 - 51 to 75 percent

5 - 76 to 95 percent

6 - over 95 percent

In addition, the general condition of dominant species will be noted collectively, with a description given of any unusual or unhealthy patterns developing.

Beginning at the four cardinal points and moving toward the center of each plot, quadrats 10.75 feet long by 1 foot wide will be measured. In these quadrats the ground cover (including all tree and shrub species less than 18 inches high) will be recorded by species and percent cover, and the general condition of dominant species noted (as was done for shrubs and small trees). A vegetation type will be determined for each plot in the field.

Plots will be grouped according to vegetation types established in the field. Within each type, frequencies will be established for all species to estimate the importance of their occurrence. Data from all plots in all types will then be combined, and an importance value index established for each species within each of the four vegetation strata (i.e., trees, understory,

shrub stratum, and ground cover). Before plots are located, all construction activities will be pinpointed so that land disturbances can be accurately assessed and that reference plots needed for future use will not be destroyed by construction activity.

Construction effects on vegetation will be assessed by remeasurements of permanent plots. The program will yield before, during, and after effects. Specific areas such as riparian woodland vegetation will be identified and marked on the ground, on maps, and on plant drawings to minimize adverse construction effects.

Birds--A system of permanent, relocatable transects will be used to inventory bird life on the site. Species composition, diversity, and relative density will be the parameters measured. In addition to terrestrial surveys, riparian habitats will also be surveyed. Spring and winter inventories of waterfowl have been conducted on the site for two years. Riparian surveys will be expanded in 1974 to include other species.

A before-and-after comparison of bird response to nuclear plant construction is the objective of the bird survey work. Bird life on areas outside of the direct impact zone will not be significantly affected by construction activities.

Reptiles and Amphibians--Reptiles and amphibians will be inventoried by intensively searching habitats using potato rakes, drift fences, and other standard techniques. Population census techniques have not been developed for herptofauna as they have for other vertebrates; thus, the assessment of these species will be qualitative in nature.

Mammals--The baseline mammal inventory will concentrate on small mammals since they are relatively easy to census and are excellent indicators of land use and cover changes.

Permanent trapping stations will be established and three trap periods will be utilized beginning in September and ending in November. Each period will run 4-5 days with three men running 200 to 300 live traps per day. Estimations of presence and relative abundance of white-tailed deer and other larger mammals in the area of direct impact will be made based on incidence of tracks, browse sign, scat, dens, and direct observation. The monitoring program to assess construction effects will measure changes in mammal abundance and distribution as well as species composition and species diversity.

6.1.4.2.3 Agricultural Land Use

Agricultural base line data will be gathered during both preconstruction and construction phases of the project. Initiated in the winter of 1973-1974, these data will be obtained for the 1,940-acre plant site and surrounding area, as well as along transmission line rights-of-way.

Soils--Using published county soil association maps, the general characteristics of soils within the north-central area of Tennessee will be prepared as general reference material. Detailed soil surveys will be examined for farms which occur within the proposed purchase boundaries. The characteristics of soils which may be directly affected by construction activities can therefore be evaluated with regard to soil erosion or crop production losses resulting from conversion of agricultural land to industrial uses. The feasibility of monitoring soil erosion losses before and during construction is being studied for measuring sediment accumulation in several strategically placed wier structures on the site.

Crops--Acreages of various kinds of agricultural crops occurring on the proposed nuclear plant site will be determined by field inspection and TVA records. Aerial photographs and high altitude infra-red photography will be used to identify croplands occurring within a 5-mile radius of the plant site, to serve as a base for monitoring future land use changes.

Livestock--During preoperational stages, an estimate of numbers of cattle, hogs, sheep, and other farm animals occurring within the purchase boundaries and 5-mile radius from the plant site will be made. Field inspections, personal interviews, and use of secondary agricultural census data will be used to make these estimates. This information will serve as a base for monitoring possible changes in livestock populations as related to long-term farming and land use changes in the region surrounding the nuclear plant.

6.1.4.2.4 Cooling Tower Drift Related Studies

Terrestrial monitoring programs could be needed to assess the possible effects of heavy metals and salts in cooling tower drift and its deposition and accumulation in soils, crops, and vegetative and animal life in the areas surrounding the plant site. It will be necessary to obtain appropriate baseline data in order to make this assessment if warranted.

Soils--Soil samples will be taken from permanently established one-fifth acre sampling plots, located at various distances from the cooling towers. (These sampling sites would also be used for subsequent operational monitoring of agricultural and other vegetation.) The location of these soil sampling sites will be approximately 500, 1,000, and 2,000 meters from the cooling towers and beyond depending on predictions of the model. The sites will be in two directions from the towers: (1) expected path of maximum potential deposition of salts and heavy metals, and (2) expected path of minimum potential deposition of substances. Soil sampling depths should be

as follows: humus layer (if present), and 0-1 cm, 1-5 cm, and 15-20 cm depths of the mineral soil. Only one sampling time would be required during the preoperational stage.

Crops--Vegetative samples, particularly from pasture and hay crops, will be taken from permanently established one-fifth acre plots as described earlier. On pasture or hay crops, samples would be taken three times a year for one growing season during the preoperational stage. Forage clippings will be taken from replicate subplots (under wire cages) within each one-fifth acre plot. On each site, clippings will be taken to represent several stages of plant maturity (different clipping time intervals). This initial sampling will serve as a base for making comparisons with later plant tissue analyses obtained for operational phases of the nuclear plant.

Natural Vegetation--Transects similar to those described above for soils will be used to locate sampling points (500, 1,000, 2,000 meters) within non-agricultural vegetation types (hard wood and coniferous forest types). Plant sampling schemes for plots will be similar to those described for the two preceding subsections. Samples will be taken during winter (January-February) and late summer (August) to evaluate differences attributable to uptake during the plant production phase, as well as the effect of foliage cover on inputs to soils.

At least five replicate samples will be taken at each point along the transect for each component sampled in each sampling period. A variety of overstory, understory and ground cover (herbaceous) plants will be sampled and analyzed to determine where elements and salts listed in table 6.2-5 accumulate in the plant community structure. Plant components (seeds, foliage, etc.) known to be important wildlife foods will be assayed to determine their role (if any) in concentrating and transferring these elements and salts to herbivores (mainly small mammals). In summary, this sampling design will

assess the role of various non-agricultural vegetation types and associated soils in the accumulation and transport of selected salts and elements which occur in cooling tower drift. Qualitative and quantitative estimates of the effects of drift components on plant health, growth and composition will also be determined by observation and subsampling on the plots to provide baseline (preconstruction) data.

Small Mammals--Plots selected for soil and natural vegetation analysis will be evaluated by a vertebrate zoologist to determine species of small mammals which can easily be snap-trapped. An attempt will be made to collect individuals of insectivorous and herbivorous species (i.e., shrews, white-footed mice, and pine voles). Collections will be made from selected plots used for natural vegetation analyses. Animals will be assayed for elements and salts included in Table 6.2-5 of Section 6.2.5. As in the natural vegetation and soils monitoring programs, the goal will be a before and after analysis of selected small mammal species to determine the nature of cooling tower drift uptake.

6.1.4.2.5 Demographic Surveys

Present population data is based on the 1970 Census of Population. Future population is based on projections prepared for counties by the Social Science Advisory Committees for Tennessee and Kentucky and published by the Environmental Protection Agency[7] in July 1972.

Distribution of the population into the various segments found in Section 2.2 was done on the basis of subcounty allocation and community projections prepared by TVA. Within 10 miles, this was done through the use of county highway maps which show dwelling units using an average person per household to estimate the population. Between 10 and 50 miles, judgment based on recognition of significant factors such as major highways, topography, and past trends is used to allocate subcounty areas (county census divisions and towns) where they are cut by circles and radii.

Transient population data were based on 1971 annual visitation data obtained from the U.S. Corps of Engineers' Nashville District Office.[8] TVA prepared the 1971 peak-hour estimates based on estimated July 4 levels of use. Future peak-hour use was estimated by TVA using projected regional changes in recreation participation as reported in the 1969 Tennessee Statewide Comprehensive Outdoor Recreation Plan.[9]

6.1.4.3 Noise Levels from Construction Activities

Community noise impact could be realized from construction activities, such as land clearing, excavation, drilling, steel erection, and movement of materials (rail and truck). Ambient noise will be monitored at site boundaries, selected community locations, and possibly at selected locations associated with construction of power transmission systems. Sampling will be performed daily for periods of time sufficient to reflect daytime and nighttime noise levels.

Listening station locations may include cardinal compass points on the site boundaries, at residential areas in Hartsville, and at the county school in Hartsville.

Monitoring will be achieved largely by the use of mobile listening stations which may be relocated as need arises. However, some fixed listening stations may be indicated.

Monitoring will continue throughout the construction period in order to demonstrate noise impacts from various construction phases and to show noise levels as a function of diurnal and seasonal changes.

6.1.5 Radiological Surveys

Preoperational radiation levels at the site and environs are discussed in Section 2.8. The preoperational environmental radiological monitoring program, including the rationale for the identification of sampling and collection sites, sampling methods, duration and frequency, and analytical procedures is discussed in Section 6.2.1.2.

References for Section 6.1

1. "Guidelines: Biological Surveys at Proposed Heated Discharge Sites," Environmental Protection Agency.

2. "Laboratory Operating Procedures," I-WQ-74-2, TVA Division of Environmental Planning.

3. D. H. Slade, "Meteorology and Atomic Energy, 1968," AEC Report TID-24190, July 1968.

4. "Atmospheric Diffusion Experiments with SF_6 Tracer Gas at Three Mile Island Nuclear Station Under Low Wind Speed Inversion Conditions," Pickard, Lowe, and Associates, Inc., The Reserach Corporation of New England, General Public Utilities Service Corporation, January 1972.

5. Population by County, Historic (1940-1970) and Projected (1980-2020), Environmental Protection Agency, Region IV, Atlanta, Georgia, 1972.

6. Personal Communication from Mr. Howard Boatman, Chief, Operations Division, Nashville District, U.S. Corps of Engineers, to Mr. Jack H. Hendrix, Chief, Recreation Resources Branch, TVA, November 21, 1973.

7. "Tennessee Statewide Comprehensive Outdoor Recreation Plan"--1969. Statistical Summary - Regional Demand, Supply, and Comparisons, Final Report, Appendix III. Published by the State of Tennessee, Department of Conservation, 1969.

TABLE 6.1-1

NONRADIOLOGICAL (WATER QUALITY) MONITORING

STATIONS FOR HARTSVILLE NUCLEAR PLANT

Station CRM	Horizontal Location (Percent from left bank looking downstream)	Depth Ft.	Description
262.9	20	S,M,B[1]	City of Lebanon, Tennessee, water intake
278.6	80	S,M,B	City of Hartsville, Tennessee, water intake
284.5	25-75[2]	S,M,B	Point approximate--to be 500 ft. downstream from blowdown discharge structure
285.0	70	S,M,B	Point approximate-site of plant intake structure
292.4	33	S,M,B	Near the mouth of Round Lick Creek. Upstream control station deemed to be sufficiently upstream to be above influence of construction and heat wedges.

1. Surface, mid-depth, bottom---one foot below the surface and two feet above the bottom; and mid-depth
2. Depending on type of discharge structure used and placement in Cumberland River.
3. Stations are to be permanently buoyed or adequately marked on shore to ensure that the same locations are sampled each time.

Note: Temperature profiles are to be 0.25, 1, 2, 5, 10, 15 feet, etc. However, intermediate depths are to be observed to limit temperature differences to 1^{o} C between successive readings. DO profiles are to be at 5-foot intervals.

Table 6.1-2

NONRADIOLOGICAL (BIOLOGICAL) MONITORING

STATIONS FOR HARTSVILLE NUCLEAR PLANT

Station CRM	Zooplankton	Phytoplankton[2]	Benthic Fauna (Ponar)	Benthic Fauna (Artificial Substrates)	Sediment	Periphyton
292.4			10[3]	3	1	2
285.0	VH,2[1]	0,1,3,5 m	10	3	1	2
283.5			10	3	1	2
278.6	VH,2	0,1,3,5 m	10	3	1	2

1. Replicate bottom-to-surface vertical hauls.
2. Replicate samples.
3 Ten samples per stratum. A stratum must represent 10 percent of total substrate in area from right bank to left bank.

Table 6.1-3

NONRADIOLOGICAL AQUATIC BIOLOGICAL MONITORING - HARTSVILLE NUCLEAR PLANT SITE - CUMBERLAND RIVER

Parameter	Calendar Year	Survey Frequency	Analysis
enthos	1974, 1975	Quarterly (Jan.-Mar.) Monthly (April-Sept.) Quarterly (Oct.-Dec.)	Genus, species; numbers (per unit area); biomass (per unit area)
hytoplankton	1974	Quarterly (Jan.-Mar.) Monthly (April-Sept.) Quarterly (Oct.-Dec.)	Genus; numbers per unit volume[1]; % composition (green, diatom, blue-green); chlorophyll *a* estimate of biomass standing crop
ooplankton	1974	Quarterly (Jan.-Mar.) Monthly (April-Sept.) Quarterly (Oct.Dec.)	Genus, species; numbers per unit volume[1]; biomass per unit volume[1]
eriphyton	1974, 1975	Monthly (April-Sept.)	Autotrophic-heterotrophic index; genus; % composition (green, diatom, blue-green)
ediment	1974, 1975	Quarterly (Jan.-Mar.) Monthly (April-Sept.) Quarterly (Oct.-Dec.)	Particle size (pipette analysis); total organic carbon
rtificial substrates	1974, 1975	Quarterly (Jan.-Mar.) Monthly (April-Sept.) Quarterly (Oct.-Dec.)	Genus, species; numbers per unit; biomass per unit
orbicula (artificial substrates)	1974, 1975	As deemed necessary	Growth (biomass and growth in mm over time)

. Depths integrated to give data for square area.

ote: Contents of this table represent a minimum program. TTU may collect other data on their initiative and expense.

Table 6.1-4

CONSTRUCTION IMPACT ASSESSMENT SAMPLING SCHEME

roup	Parameters	Sample Technique	Schedule	Evaluation
egetation[a]	Relative density Relative basal area Relative frequency Importance value	Permanent Fixed 1/5-acre plots, 1/100-acre plots, square Meter plots	Once during pre- operational phase, once during operational phase.	Evaluate before and after results of nuclear plant construction.
reeding Birds[b]	Species composition Relative Density Species diversity	Permanent transects	Twice prior to construction. Twice after plant becomes operational	As above.
mall Mammals[c]	As for breeding birds	Permanent fixed grid live trapping	Twice prior to construction. Twice after plant becomes operational.	As above.
eptiles and Amphibians	Presence	Habitat search	Once prior to construction.	Assess populations.

. Vegetation parameters and their derivation are discussed in Quantitative Plant Ecology by Greig-Smith (1964) and Chapman and Meyer (1949).

. Parameters for breeding birds have been discussed by Bond (1957).

. Mammal censusing techniques are discussed in Wildlife Investigational Techniques by Giles (1969).

Table 6.1-5

DEFINITION OF PARAMETERS USED TO ASSESS CONSTRUCTION IMPACTS

<u>Vegetation</u>—Importance Value (IV) was measured in three ways:

For the trees:

IV = (Relative Density + Relative Frequency + Relative Basal Area) + 3

Where

$$\text{Relative Density} = \frac{\text{Number of trees of a single species}}{\text{Total number of all trees}} \times 100,$$

$$\text{Relative Frequency} = \frac{\text{Number of occurrences of a single species}}{\text{Total number of occurrences of all species}} \times 100,$$

$$\text{Relative Basal Area} = \frac{\text{Basal area of a single species}}{\text{Total basal area of all species}} \times 100.$$

For the understory:

$$\text{IV} = \frac{\text{Relative Density + Relative Frequency}}{2}$$

For shrub stratum and ground cover:

$$\text{IV} = \frac{\text{Relative Frequency + Relative Cover}}{2}$$

Where

$$\text{Relative Cover} = \frac{\text{Percent cover of a single species summed over all subplots or quadrats}}{\text{Sum of the percent covers of all species in all subplots or quadrats}} \times 100.$$

By dividing by the appropriate denominator, Importance Values are assigned to a linear scale ranging from 0 to 100. Since the sum of IV's of all species within a particular stratum totals 100, each IV can be viewed as a measure of the relative percentage of importance of that species in the stratum.

Breeding Birds and Small Mammals:

Species Composition - Simply a listing of all birds found per habitat type.
Relative Density - Expressed as number of birds per 100 acres of each habitat type.
Species Diversity - Ratio between number of species and numbers of individuals.

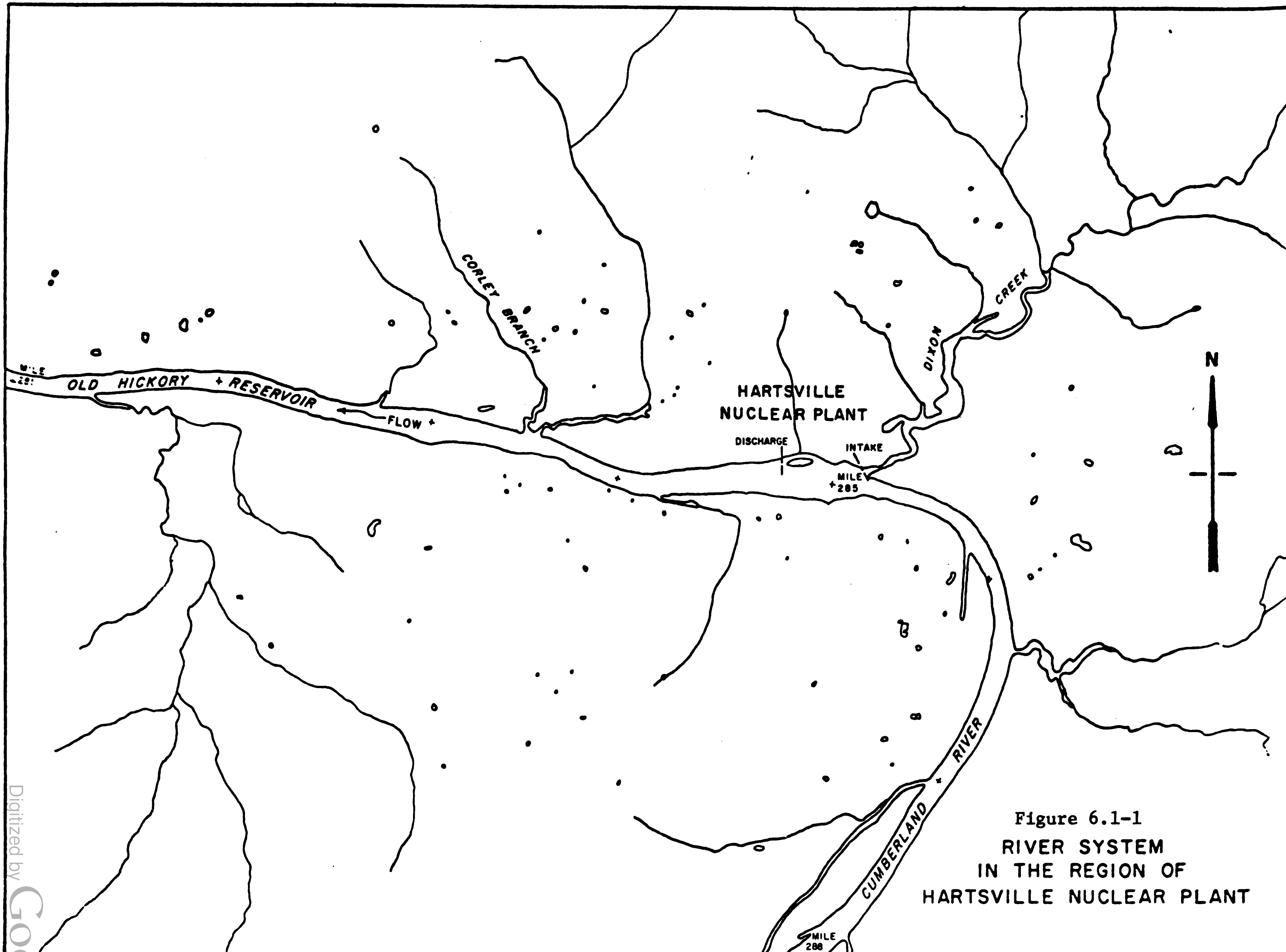


Figure 6.1-1
RIVER SYSTEM
IN THE REGION OF
HARTSVILLE NUCLEAR PLANT

FISH MONITORING STATIONS, CUMBERLAND RIVER
NEAR DIXON SPRINGS, TENNESSEE

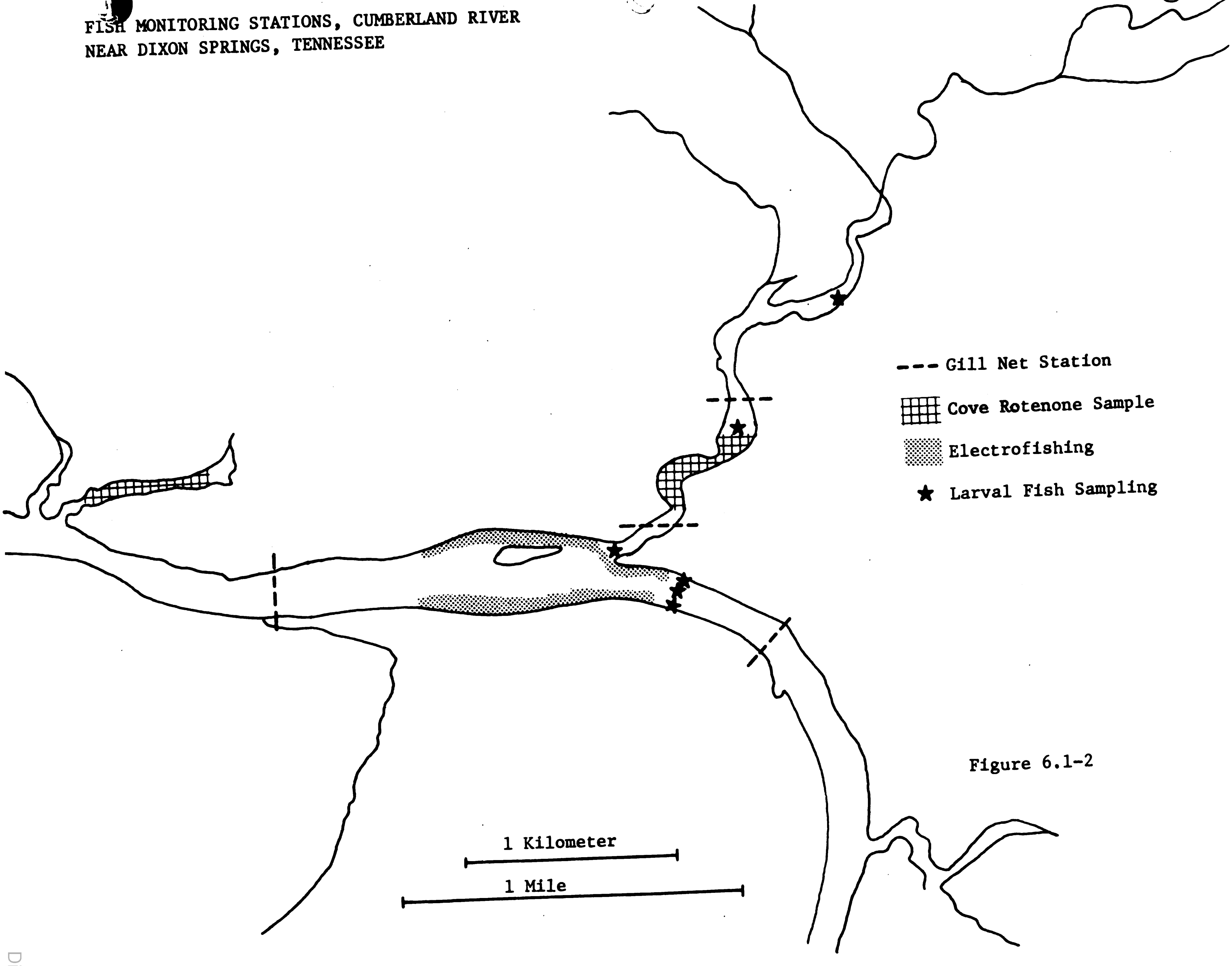
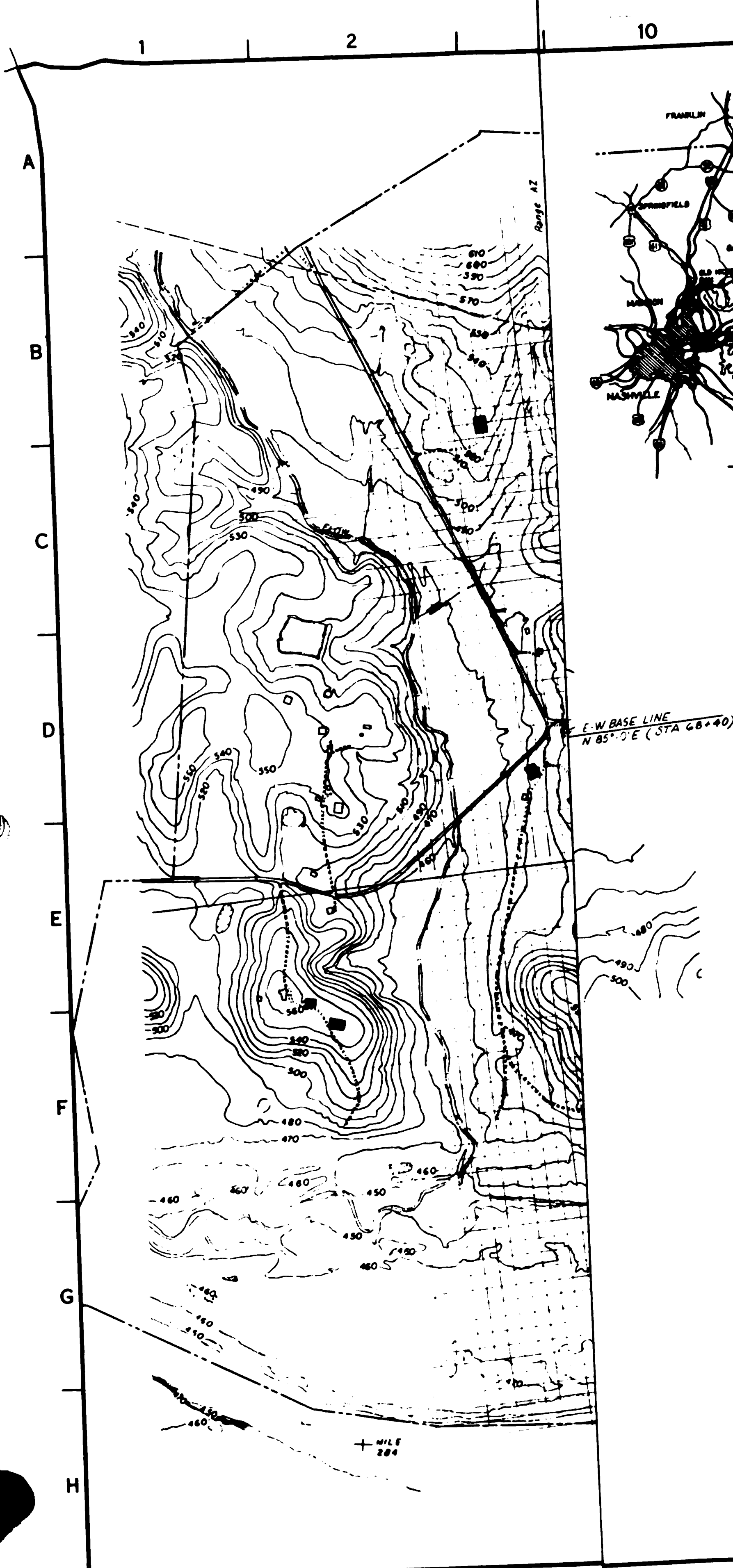
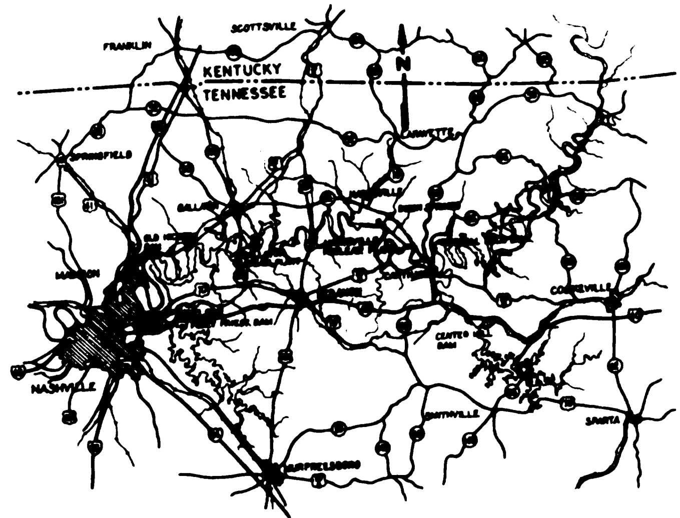


Figure 6.1-2

6.3 6.2





LOCALITY MAP

NOTES
1. TOPOGRAPHY TAKEN FROM KELSH TWO FEET CONTOUR TOPOGRAPHY DATED JUNE, 1973, REDUCED. CONTOUR INTERVAL SHOWN IS 10 FEET, EXCEPT AS NOTED

LEGEND
▲ LOCATION OF SOIL SAMPLE HOLES.

Figure 6.1-3

SITE STUDIES

LOCATION GRID FOR SOILS INVESTIGATION

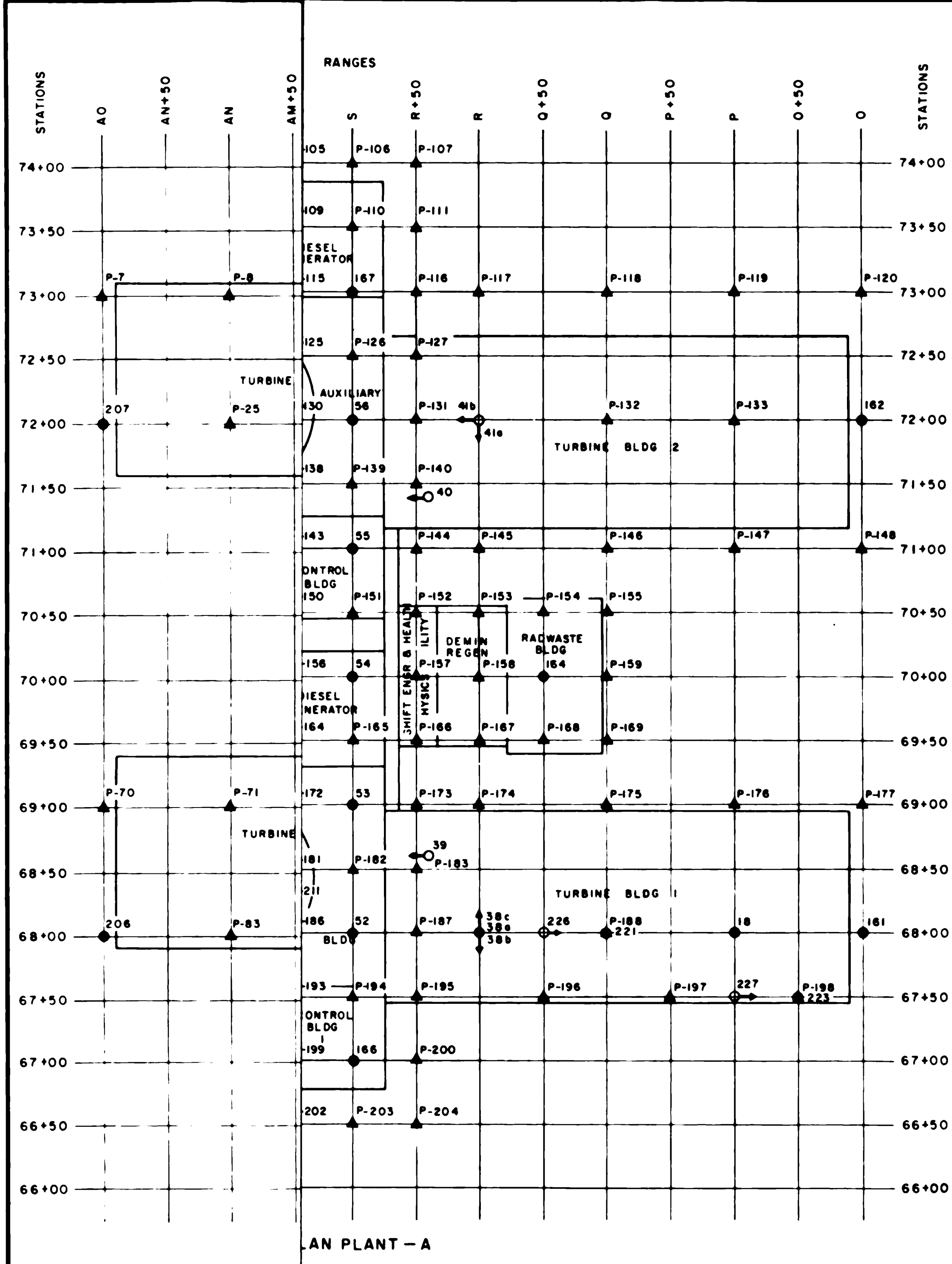
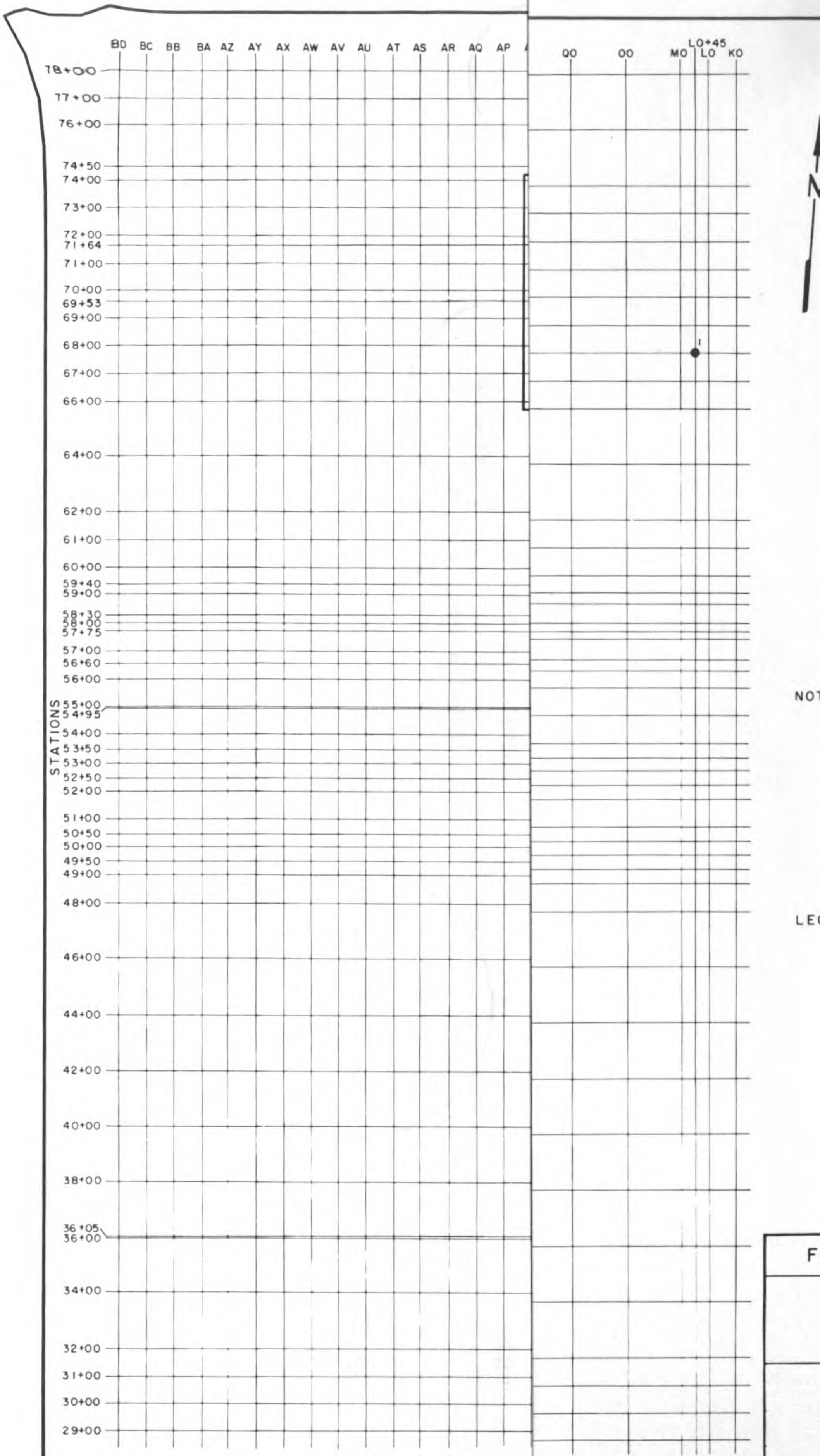


Figure 6.1-4

DETAILED EXPLORATION LAYOUT OF PLANT AREAS



NOTE.
For locations of angled drill holes, see Drilling Summary.

LEGEND:
● 26 Numbered drill hole

Figure 6.1-5

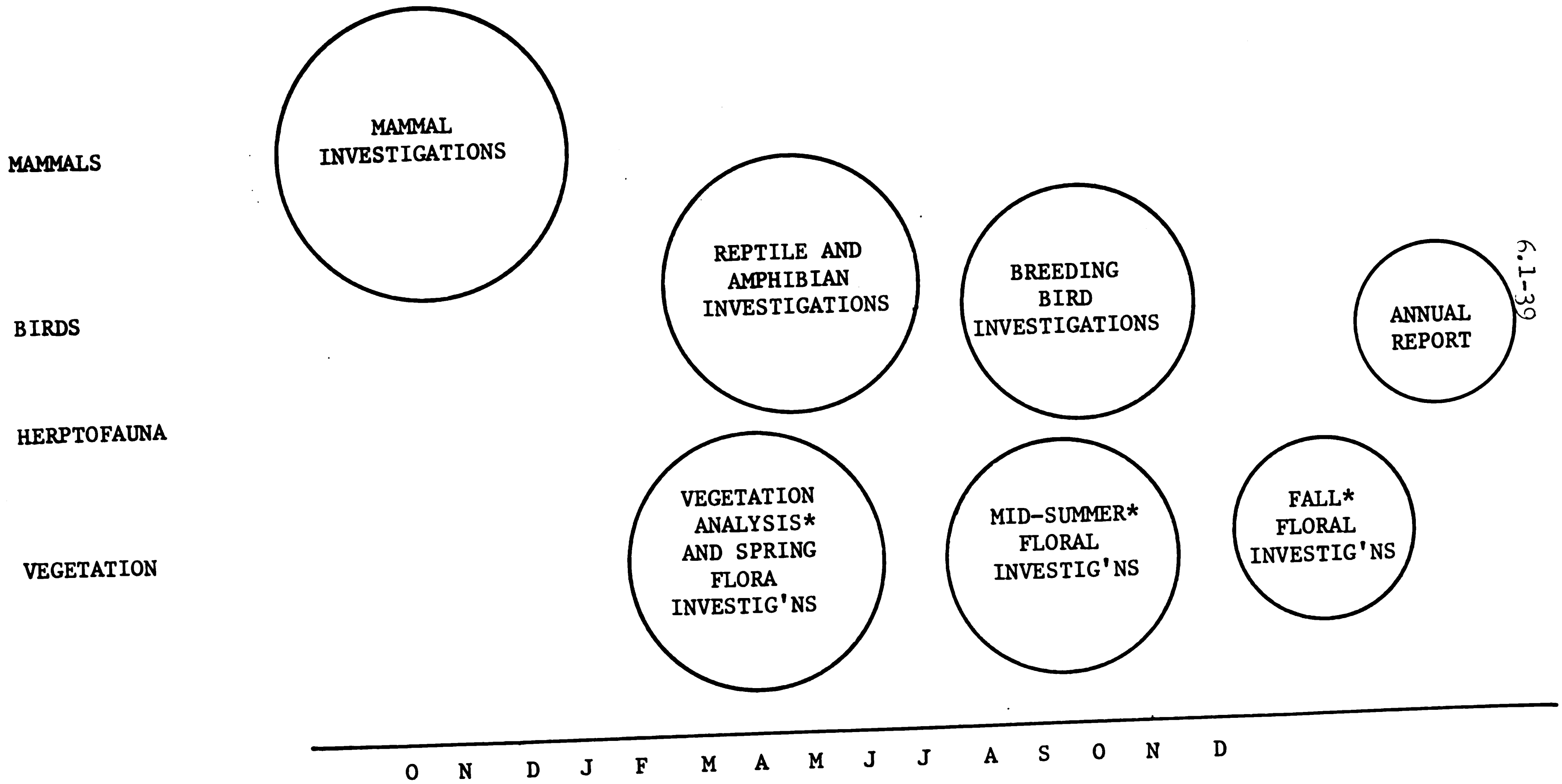
FOUNDATION INVESTIGATIONS

EXPLORATION DRILL LAYOUT

RECORD DRAWING AS CONSTRUCTED

Figure -6

PREOPERATIONAL SAMPLING SCHEME FOR BASELINE AND CONSTRUCTION MONITORING



*Vegetation information not collected each year. (See Table 6.1-4)

6.2 Proposed Operational Monitoring Programs

6.2.1 Radiological Monitoring

6.2.1.1 Plant Effluent Monitoring

The Hartsville Nuclear Power Plant process and effluent radiation monitoring system will continuously monitor and record the radioactivity of all liquid and gaseous effluent streams which release or have the potential of releasing radioactivity to the environment. Sampling and laboratory analysis will be used to identify the type and quantity of radionuclides and establish the typical effluent mix. This information will be used to compute total release to the environment. The process and effluent radiation monitoring subsystems used for this purpose are:

1. Plant ventilation exhaust
2. Radwaste building exhaust
3. Turbine building exhaust
4. Process liquid

6.2.1.1.1 Plant Ventilation Exhaust

The plant exhaust ducts vent the fuel handling building, auxiliary building and containment building. To monitor the plant exhaust, a gas sample is drawn through an isokinetic probe located high enough in the stream to assure representative sampling. The sample passes through a particulate filter, a halogen filter, and a shielded sample chamber where the radiation is measured by a gross gamma scintillation detector located in the shielded chamber. The halogen and particulate filters are routinely analyzed in a laboratory. Capabilities of the monitoring channel are listed in table 6.2-1.

6.2.1.1.2 Radwaste Building Exhaust

The radwaste building exhaust is continuously monitored for radioactivity release by an off-line gamma detector. A gas sample is drawn through

an isokinetic probe, a particulate filter, a halogen filter, and a shielded sample chamber where the radiation is measured by a gamma-sensitive scintillation detector located in the shielded chamber. The halogen and particulate filters are routinely analyzed in a laboratory. Capabilities of the monitoring channel are listed in table 6.2-1.

6.2.1.1.3 Turbine Building Exhaust

All turbine building areas are vented to a common exhaust vent. A gas sample is drawn through an isokinetic probe located high enough in the stream to assure a representative sample. The sample passes through a particulate filter, a halogen filter, and a shielded sample chamber where the radiation is measured by a gamma scintillation detector located in the shielded chamber. The halogen and particulate filters are routinely analyzed in a laboratory. Capabilities of the monitoring channel are listed in table 6.2-1.

6.2.1.1.4 Process Liquid

Process liquid radiation monitors are installed in all liquid streams which release radioactivity or have the potential of releasing radioactivity to the environment. Upon detection of high radioactivity in a stream, the stream is isolated. Actual control of liquid releases are via laboratory analysis and controlled flow from holdup tanks.

Each channel has a gamma scintillation detector and a radiation monitor. A sample of the process liquid is passed through a shielded sample chamber for measurement of gamma activity. The monitors and recorders are located in the control room, except that the radwaste system recorder is located on the radwaste main control panel. Capabilities of the monitoring channel are listed in table 6.2-1.

6.2.1.2 Environmental Radiological Monitoring

This section describes the radiological surveillance program proposed for the Hartsville Nuclear Plant. The types of samples to be collected, sampling locations and frequency, and the analyses to be performed on each sample are discussed for both the preconstruction-construction phase and the preoperational-operational phase. The discussion also includes rationale for the choice of sampling locations, types of samples to be collected, and the collection frequency.

The reported analytical sensitivities will be those concentrations numerically equal to the 2-sigma counting error associated with the analysis when standard sample sizes and counting times are employed. The sensitivities will therefore be those concentrations below which it is impossible to state at the 95-percent confidence level that any amount of radioactivity exists in the sample.

Environmental radioactivity monitoring reports will be submitted to the AEC semiannually.

6.2.1.2.1 Preconstruction-Construction Phase

The objective of the preconstruction-construction environmental radiological monitoring program is to establish the distribution of natural and man-made radioactivity in the environment near the plant site prior to and during construction of the plant. Construction activities in the Cumberland River will disturb the existing bottom sediment, resuspending

part of it in the river. The purpose of this monitoring program is to determine the effect of these construction activities on the reservoir environment. To achieve this, reservoir water and bottom sediment samples will be collected from three sample points; one point above the proposed plant intake at CRM 292.4; one below the proposed plant discharge at CRM 284.5; and one at the nearest public water intake at CRM 278.6. These samples will be analyzed for gross beta, gross alpha, ^{89}Sr, and ^{90}Sr. The activity of at least ten gamma-emitting radionuclides will be determined with a multichannel gamma spectrometer. Reservoir water samples will also be analyzed for tritium. The water samples will be collected continuously and analyzed monthly, and the bottom sediment samples will be collected and analyzed quarterly. Locations of sampling stations are shown in Figure 6.2-1. This phase of the monitoring program will be initiated approximately 6 months prior to construction activities at the site.

6.2.1.2.2 Preoperational-Operational Phase

General--The preoperational environmental radiological monitoring program has the objective of establishing a baseline of data on the distribution of natural and man-made radioactivity in the environment near the Hartsville Nuclear (HNP) site. With this background information, it will then be possible to determine, when the plant becomes operational, the earliest possible indications of the accumulation or buildup of radionuclides. During the life of the plant this accumulation should exist in no more than trace amounts, with only minor impact on the environment.

A study of environmental radiation levels will be initiated at least two years before startup and will continue through low-power testing and operation of the plant.

The environmental monitoring program outlined herein is subject to change based upon continued evaluation of programs now being conducted within the Tennessee Valley region and upon other available data. The

program will be coordinated closely with other agencies' programs, such as the nationwide fallout sampling and water quality networks and the radiological health program of the State of Tennessee.

The program will include measurements of direct gamma radiation and sampling of airborne radioactivity, fallout particulate matter, rainfall, well and public water supplies, soil, vegetation, milk, fish, clams, bottom sediment, plankton, and river water. The extent to which various aspects of the program will be carried out takes into account data available from other sources; however, the program as outlined is self-sufficient. It will be continually evaluated to determine that the most sensitive vectors are being sampled to properly evaluate exposure of the population. Continual evaluation also allows planning an effective system with respect to sampling frequencies, locations, and laboratory analyses.

Atmospheric Monitoring--Ten atmospheric monitoring stations will be established for the HNP. Four of these monitors will be located on or adjacent to the plant site in the sectors having the greatest wind frequency One additional station will be placed at the point of maximum predicted offsite concentration of radionuclides if this point varies significantly from the above 4 locations. Four other stations will be located at perimeter areas out to 10 miles. These stations will be instrumented and will telemeter data into the control room. Two additional monitors will be located at distances out to 22 miles (see figure 6.2-1). These remote monitors will be used as control or baseline stations. Locations for sampling stations were chosen after considering meteorological factors and population density around the site. Samples of air, rainwater, and heavy particle fallout will be collected routinely as indicated in table 6.2-2.

<u>Terrestrial Monitoring</u>--Samples of milk, vegetation, pasturage, soil, private well water, public water supplies, and food crops will be collected within a 10-mile radius of the plant. Environmental gamma radiation levels will be measured utilizing thermoluminescent dosimeters on a 500-foot grid within the plant boundaries and at each offsite atmospheric monitoring station. At least two dosimeters will be placed at the locations of highest predicted ground level concentrations. All dosimeters will be left in the field for three months.

Milk will be collected monthly from selected dairy farms, immediately surrounding the plant, and from public supplies by purchasing quantities from food stores in the area. The samples will be analyzed for specific gamma-emitting radionuclides and, radiochemically, for ^{89}Sr and ^{90}Sr. After the plant begins operation, during the seasons that animals producing milk for human consumption are on pasture, samples of fresh milk will be obtained weekly and analyzed for ^{131}I content. During the remainder of the time milk samples will be analyzed monthly. During periods of monthly milk sampling, if an increase in ^{131}I content is detected in other critical vectors such as vegetation, the frequency of milk sampling will be increased.

Vegetation (grass, weeds, leaves, etc.) and soil samples will be collected quarterly from the vicinity of the atmospheric monitoring stations. The same rationale for locating the atmospheric monitors is applicable to this program. In addition, pasturage will be collected monthly from the farms mentioned in the preceding paragraph. The sampling and analysis schedule is shown in Table 6.2-2.

Private well water in the vicinity of the plant will be sampled monthly, and public water supplies within 10 miles of the plant will be sampled continuously and analyzed monthly. Food crops grown by subsistence farmers in the area will be sampled during the growing season.

Consideration has been given to sampling animals such as cattle raised in the vicinity of the nuclear plant. Pasturage will be collected monthly from the dairy farms. This vector would be the first indicator in the food chain to man through animal. If a statistically significant increase above the natural background established during the preoperational monitoring program is detected, the program will be expanded to include other vectors in the food chain such as beef cattle.

Reservoir Monitoring--Biological sampling for radiological analyses will be carried out quarterly at three river stations in Old Hickory Reservoir. The stations will be located above and below the plant site as indicated in Figure 6.2-2 at Cumberland River miles (CRM) 278.6, 285.0, and 292.4.

Reservoir water samples will be collected continuously from stations at CRM 262.9, 278.6, 284.5, and 292.4 and analyzed monthly for radioactivity content (see Figure 6.2-2). The station at CRM 284.5 will be located approximately 500 feet below the plant discharge. Samples collected for radiological analysis will include water from four stations and fish from three reservoirs. Bottom fauna (Asiatic clams), plankton, and sediment samples will be taken from three stations. Further sampling information can be found in Tables 6.2-2 and 6.2-3 and Figure 6.2-2.

Gamma, gross alpha, and gross beta activity will be determined in water (dissolved and total activity), plankton, sediment, shells and flesh of clams, flesh of two commercial and one game fish species, and the whole body of one commercial fish species. Reservoir water samples will also be analyzed for tritium. Except in the flesh of clams, white crappie and channel catfish, ^{89}SR and ^{90}Sr content will be determined in all samples. The activity of at least ten gamma-emitting radionuclides will be determined with a multichannel gamma spectrometer.

At present it is felt that this program will sample those vectors which will give the first indication of increased radioactivity levels in the environment. If statistically significant increases above natural preoperational background are seen in those vectors being sampled, consideration will then be given to expanding the sampling program to include other biological parameters.

Consideration has been given to sampling waterfowl; however, about 95 percent of ducks hunted in Tennessee are migratory, moving great distances in the winter and spring. It would be impossible to make an accurate assessment of any radionuclides found in migratory waterfowl to a particular source such as the HNP. Therefore, it seems more logical to sample other vectors in the environment which the waterfowl might inhabit for short periods of time.

Water. Water samples will be collected for determination of total and dissolved radioactivity from the four stations. Water samples will be taken by a sequential-type sampler monthly for gross beta, gross alpha, and specific gamma-emitting radionuclides, ^{89}Sr, ^{90}Sr, and ^{3}H.

Buildup of radioactivity in Old Hickory Reservoir is not expected; however, if it does occur, it will occur slowly over a long period of time. The frequencies established in the present program are satisfactory to detect this gradual effect.

Fish. Radiological monitoring will be accomplished by analyses of composite samples of adult fish taken from each of three contiguous reservoirs—Cordell Hull, Old Hickory, and Cheatham. No permanent sampling stations have been established within each reservoir; this is due to the known movement of fish species within reservoirs as determined by TVA data from the Browns Ferry Nuclear

Plant preoperational monitoring program. Three species, white crappie, channel catfish, and smallmouth buffalo, will be collected representing both commercial and game species. For each of the following composites, sufficient fish will be collected in each reservoir to yield from 250 to 300 grams oven-dry weight for analytical purposes:

Flesh - white crappie

Flesh - smallmouth buffalo

Flesh - channel catfish

Whole fish - smallmouth buffalo

All samples are collected quarterly and analyzed for gamma, gross alpha, and gross beta activity. Concentrations of ^{89}Sr and ^{90}Sr will be determined on the fish and flesh of smallmouth buffalo only. The composite samples will contain approximately the same quantity of flesh from each of the fish. For each composite a subsample of material will be drawn for counting. The channel catfish is considered to be representative of piscivorous species of fish.

Plankton. For radiological analyses plankton samples will be collected at three stations by bottom-to-surface vertical hauls (see table 6.2-3). For analytical accuracy at least 50 grams (wet weight) of material is desirable; and collections of such amounts are practical only during the period April through September because of seasonable variability in plankton growth. Samples will be analyzed for gamma, gross alpha, and gross beta activity, and for ^{89}Sr and ^{90}Sr content.

Sediment. Sediment samples will be collected from Ponar dredge hauls. Gamma, gross alpha, and gross beta activity, and ^{89}Sr and ^{90}Sr content will be determined in samples collected from three stations. Each sample will be a composite obtained by combining equal volumes of sediment from at least three dredge hauls collected from each station at a single point.

Asiatic Clams. Asiatic clams will be collected by Ponar dredge hauls at three stations as shown in table 6.2-3. These samples will be analyzed for gamma, gross alpha, and gross beta activity. The ^{89}Sr and ^{90}Sr content will be determined on the shells only. A 50-gram (wet weight) flesh sample is needed to provide sufficient activity for counting.

Domestic Water Supplies--Domestic water supplies, such as small surface streams and wells, will be sampled and analyzed. Well water will be obtained from at least two farms located near the plant. Public water supplies within 10 miles downstream of the plant discharge will be sampled continuously and analyzed monthly for gross beta, tritium, and at least ten specific gamma-emitting radionuclides.

Quality Control--A quality control program will be established. TVA has similar programs in effect with the Tennessee Department of Public Health Radiological Laboratory and the Eastern Environmental Radiation Facility, Environmental Protection Agency, Montgomery, Alabama. Samples of air, water, milk, vegetation, and soil collected around the plant will be collected and submitted for analysis. Results will be exchanged for comparison.

6.2.2 Chemical Effluent Monitoring

The onsite chemical effluent monitoring program for the plant is designed to meet applicable state and/or Federal requirements. Additional monitoring may be provided as required to meet future applicable regulations.

Effluents to the receiving stream include those from the discharge pond and the yard drainage ponds. Influent streams to these ponds are individually monitored.

The condenser circulating water will be monitored for chlorine and the raw cooling water system for acrolein during injection periods to assure that residuals are depleted before tower blowdown is resumed to the receiving stream.

Table 6.2-4 lists the systems to be sampled, the location and frequency of sampling, and the analyses to be performed. Data on instrument sensitivities will be supplied later. Instrument selection for the monitoring program will be delayed as long as practicable to assure that state-of-the-art instrumentation is provided.

Figure 6.2-3 is a flow diagram depicting the various effluent paths and shows the chemical parameters to be monitored for each path.

6.2.3 Thermal Effluent Monitoring

The operational monitoring program will have as its foundation the nonradiological technical specifications for the Hartsville Nuclear Plant. These specifications will be based on the information gathered during the preconstruction stage of the monitoring program. Based upon acquired data, some parameters or even sampling stations may be deleted. Conversely, information gained in the future may indicate the need for additional parameters or stations.

A detailed thermal monitoring program will be available at the time of application for an operating license.

6.2.4 Meteorological Monitoring

This section describes the continuing environmental meteorological monitoring program for the Hartsville Nuclear Plant during the operational phase.

6.2.4.1 Objectives

The principal objectives discussed in Section 6.1.3 for the preconstruction and construction phases are similar to those identified with the operational phase. However, the rationale for the operational phase is somewhat different as the monitoring program will be designed to identify the environmental impacts from cooling tower operations based on actual field measurements. The models used to estimate cooling tower plume lengths and the occurrence of river fogging from blowdown discharge will be verified and upgraded. Similarly, the occurrence of related fogging and icing will be monitored. Other plume related effects such as local precipitation, cloud formation, solar insolation depletion, etc., will be documented. Special attention will be given to providing the necessary meteorological support for evaluating the effects of cooling tower effluent releases on air and soil moisture, plant growth, and other possible impacts on the plant site ecology.

6.2.5 Ecological Monitoring

6.2.5.1 Water Quality and Limnology

The operational monitoring program will have as its foundation the nonradiological technical specifications for the Hartsville Nuclear Plant. These specifications will be based on the information gathered during the preconstruction stage of the monitoring program. The limnological and water quality parameters will probably remain closely adherent to those listed in the construction phase. Based upon acquired data, some parameters or even sampling stations may be deleted. Conversely, information gained in the future may indicate the need for additional parameters or stations.

6.2.5.2 Fish Monitoring

Operation of the plant will result in three main categories of nonradiological impact on fish: heated water discharges, impingement of organisms on trash-collecting screens, and entrainment of fish. Most of the monitoring will be done in the area very near the plant, where any impacts should be most pronounced. No reservoir-wide monitoring is contemplated.

6.2.5.2.1 Rationale

A monitoring program will show the changes in the distributions of fish in response to heated water. Certain species of fish may be attracted to heated water during winter or repelled during summer. Sampling for species composition and numerical abundance will be concentrated in the overbank areas influenced by the heated discharge.

Other effects of heated water can be hypothesized; however, these effects would be less obvious than changes in species composition, abundance, and distribution. Monitoring of these more subtle effects is not planned.

While the number of fish impinged on screens can be determined, the significance of this impact to total fish populations in the reservoir is not well documented. It is evident that the impact of impingement losses is related to both the total number of fish and the relative abundance of the fish species in the reservoir. The total number of fish impinged will be estimated from the sampling at the plant and compared to the estimated figures on standing crop of fish in Old Hickory Reservoir obtained from rotenone samples to assess the impact. Studies in progress at other power generating facilities will be available prior to initial operation of the Hartsville plant. These studies will be used to develop specific impingement studies for this project.

Entrainment studies are relatively new in aquatic ecology. The significance of the entrainment impact on fish and plankton populations is not well known. The estimated numbers of larval fish entrained will be compared to the estimated total population moving past the site. In addition, the relative impact of entrainment on each species will be determined by comparisons of entrainment losses of each species versus the abundance of adults of the same species in the Reservoir. Localized impacts on the species living near the plant will be studied. Specific plans will be prepared prior to initiation of operation at the Hartsville plant.

6.2.5.2.2 Fish--Heated Water

The changes in distribution of post-larval fish caused by heated water will be assessed by rotenone sampling. Two areas, sited as close to the discharge as possible, will be sampled annually in August or September.

The choice of these months is to show relative abundance of young-of-the year fish. The experimental design is a before and after comparison of the individual species and size classes within each area. Gill net samples will also be collected at three stations located in shoreline areas of the reservoir. One station will be located in an uninfluenced area of the reservoir immediately above the plant; the other two in areas immediately below the plant. Each sample will consist of ten, 100 x 8 ft., 1-1/2-inch bar mesh sinking gill nets fished for four consecutive nights. Nets at each station will be set perpendicular to shore and in similar habitats, i.e., similar depths, bottom contours, etc., so that the nets can be treated as replicates. Each net will be fished four consecutive nights which will provide further replication.

During a calendar year, gill net sampling will be conducted during four quarters where the quarters are defined on the basis of water temperatures (° C.), as measured upstream from the plant. The quarters are: winter, less than 10° C; spring, 15-18° C; summer, at or above 25° C; and autumn, 15-18° C.

Gill net analyses will be both upstream-downstream and preoperational and operational. After initiation of plant operation, the sample sites may be changed. In this case, analytical procedures will become upstream-downstream comparisons entirely. The dependent variable will be the number of each species caught, although numbers of certain super-populational groups (e.g., game fish, shad, or sunfish) may be utilized.

6.2.5.2.3 Larval Fish

Entrainment will be assessed by weekly sampling during the approximate time period March 15-August 1. Larval fish will be sampled from

three cross sectional positions. These three positions will be sampled at each of three stations; one in Dixon Creek, one above the intake in the main channel, and one below the diffusers.

Final plant design will determine whether larval fish entrainment studies will be conducted in the intake after plant operations begin. These samples would be taken with stationary nets during periods determined by results of preoperational monitoring. Several entrainment experiments are currently being conducted at TVA plants. These experiments are designed to:

1. Evaluate the densities of larval fish at the intake versus those in the reservoir proper.
2. Establish the numbers and densities of larval fish passing through the plant versus those noted in the reservoir.
3. Evaluate the efficacy of "skimmer walls" in reducing entrainment of larval fish.
4. Document localized decreases in densities of larval fish downstream from the intake.

The results of these studies will exert a major influence on the planning of sampling and experimentation at the Hartsville plant.

<u>6.2.5.2.4 Fish Impingement</u>

Data will be routinely collected and will be in the form of one-day (24-hour) samples from one or more screens. Samples will be taken one or more times each week for the first year of operation; subsequent sampling schedules will be developed on the basis of results obtained during the first year. Fish will be identified and enumerated by species or other taxonomic groups, i.e., clupeids, ictalurids, <u>Lepomis</u>.

6.2.5.3 Terrestrial Monitoring

The monitoring programs for assessing terrestrial impacts of plant operation are essentially a continuation of the studies described in Sections 6.1.4.2.2 and 6.1.4.2.3. They include the documentation of changes in agricultural land use and, in particular, potential cooling tower-drift related consequences. These are summarized in table 6.2-5.

Cooling towers and other tall structures may have an adverse impact on migratory birds. An ongoing monitoring program is presently under way at Bull Run and Paradise Steam Plants to determine if birds fly into such structures. Results from these studies and studies at non-TVA facilities will indicate whether or not such a program is initiated at the Hartsville plant.

If unique or threatened species and habitats are discovered on the on-site or off-site impact areas (transmission corridors, railroad access), additional monitoring programs will be developed.

Transmission line rights-of-way will be monitored for long term land use changes. Aerial photography or high altitude infra-red photography will be used every five years to make observations and to detect such effects as excessively eroded agricultural lands. General changes in land use patterns may also utilize these techniques.

6.2.5.4 Noise Monitoring

Operational noise impacts may occur from some plant sources, such as pressure relief valves, circuit breakers, transformers, motors, fans, cooling towers, and rail traffic. Noise will be monitored at site boundaries (possibly at cardinal compass points) and at selected points in the community (e.g., residential areas in Hartsville and at the county school).

Monitoring schemes and instrumentation will be essentially identical to those used during the construction phase (see Section 6.1.4.3). Daily sampling for a period of about three years of stable plant operation is planned.

Reference for Section 6.2

1. "Standard Methods for the Examination of Water and Waste Water," 13th edition, 1971.

Table 6.2-1

PROCESS RADIATION MONITORING SYSTEMS CHARACTERISTICS

Monitoring Subsystems	Instrument Range*	Instrument Scale (Decade Log)
Plant Exhaust	10 to 10^6 counts/min	5
Process Liquid	10 to 10^6 counts/min	5
Radwaste Building Exhaust	10 to 10^6 counts/min	5
Turbine Building Stack	10 to 10^6 counts/min	5

*Range of measurements depends on items such as source geometry, background radiation, shielding, radiation energy levels, and method of sampling.

Table 6.2-3

RADIOLOGICAL (BIOLOGICAL) MONITORING STATIONS

FOR HARTSVILLE NUCLEAR PLANT

Station (CRM)	Zooplankton and Phytoplankton	Asiatic Clams	Sediment
292.4	VH[a]	X[b]	2[c]
285.0	VH[a]	X[b]	2[c]
278.6	VH[a]	X[b]	2[c]

a. Bottom-to-surface vertical haul
b. At least enough clams for 50 g of flesh and ground shells each
c. Duplicate sediment samples

Table 6.2-4

HARTSVILLE NUCLEAR PLANT
Chemical Effluent Monitoring Program

System to be Sampled	Sampling Location	Analysis	Frequency of Analysis	Method or Type of Analysis	Reference Standard Methods
Blowdown Discharge	Influent to collection sump	pH	Daily grab	Glass electrode	p. 276
		Suspended solids	Daily grab	Glass fiber filtration	p 537
		Chlorine	Daily grab	Amperometric	p. 382
		Oil and grease	Daily grab	Liquid-liquid extractions	p. 254
Condenser Circulating Water		pH	Continuous	Glass electrode	p. 276
		Chlorine	Continuous when/if chlorinating	Instrument	(Later)
Liquid Radwaste	Excess water tank	pH	On each batch or as required	Glass electrode	p. 276
		Suspended solids		Glass fiber filtration	p. 537
		Radioactivity		(Later)	
Yard Drainage Pond	Effluent to reservoir	Oil and grease	Daily	Liquid-liquid extraction	p. 254
		Suspended solids	Daily	Glass fiber filtration	p. 537
		pH	Daily	Glass electrode	p. 276
Sewage Treatment Plant	Effluent	Chlorine	Continuously	Instrument	(Later)
		Settleable matter	Daily	IMHOFF cone	P. 539
		BOD	Monthly	Modified winkler	p. 489
		pH	Daily	Glass	p. 276
		COD	Monthly	Dichromate reflux	p. 495
ESW Spray Pond	Effluent	Chlorine	Daily grab	Amperometric	p. 382
		Sus. solids	Daily grab	Glass fiber filtration	p. 537
		pH	Daily grab	Glass electrode	
		Acrolein	Daily when used, grab	Colormetric	(Later)
		Oil and grease	Daily grab	Liquid-liquid extraction	p. 254

W Spray Pond	Effluent	Chlorine	Daily grab	Amperometric	p. 495
		Sus. solids	Daily grab	Glass fiber filtration	
		pH	Daily grab	Glass electrode	
		Acrolein	Daily when used, grab	Colormetric	p. 382
		Oil and grease	Daily grab	Liquid-liquid extraction	p. 537
					(Later) p. 254

Table 6.2-5 Operational Impact Nonradiological Monitoring Scheme (Tentative)

Group	Rationale and Parameters	Sampling Technique	Frequency and Location	Evaluation
Soils	To measure possible toxic effects of cooling tower mist fall-out on soils. Heavy metals: Cd, Cr, Cu, Mn, Ni, Pb	Square meter subplots within permanent 1/5 acre plots. Sample humus layer, and mineral soil at 0-1, 1-5, and 15-20 cm depths.	Once during pre-operational phase, annually during operational phase. Sample sites located at 500, 1,000, and 2,000 meters from cooling towers, in dominant plume direction and also at direction of minimum wind.	Evaluate before and after effects of nuclear plant.
Agricultural Crops	To measure uptake and possible toxic effects of heavy metals and salts in hay and pasture crops as related to cooling tower mist fall-out. Heavy metals: Cd, Cr, Cu, Mn, Ni, Pb.	Square meter subplots within 1/5 acre plots. 3 stages of plant maturity (4, 8, and 12 month clipping time intervals) at each plot.	Once during pre-operational phase, 3 times per year during operational phase. Sample sites located at 500, 1,000, and 2,000 meters from cooling towers, in dominant plume direction and also at direction of minimum wind.	Evaluate before and after effects of nuclear plant.
	Monitor long-range changes in agricultural land use.	Survey of area within 5 mile radius of nuclear plant and along entire transmission line corridors, based on aerial photographic techniques.	Once every five years.	Evaluate once during pre-operational and periodically thereafter.
Livestock	To monitor long-term livestock population changes within a 5-mile radius of nuclear plant. Estimates will be made on dairy cattle, beef cattle, hogs, and sheep.	Field inspections, personal interview, and agricultural census data.	Once during pre-operational phase; bi-annually during operational phase.	Evaluate before and after effects of nuclear plant.

Table 6.2-5 (Continued)

Group	Rationale and Parameters	Sampling Technique	Frequency and Location	Evaluation
[N]atural Vegetation	To determine the role of non-agricultural vegetation and associated soils in the accumulation and transport of Cd, Cr, Cu, Mn, Ni, P, and salts such as SO_4 and Cl. The effects of these elements and compounds on plant health, productivity, and composition will also be evaluated.	Soils associated with the various communities will be sampled as listed. Plant parts (foilage, seeds, etc.) important in the transfer of elements to herbivores will be sampled in winter and late summer by clipping and obtaining litter samples. Observation and clipping and weighing will be used to examine the health and productivity.	Twice annually (winter and summer) with 5 replicate samples from each species or component examined at each location. Sample points along transects as described for soils.	Provides base-line (preconstruction data for comparison with operational data to monitor effects of listed elements and salts on nonagricultural vegetation.
Small Mammals	To measure uptake and effects of heavy metals and salts on insectivorous and herbivorous small mammal species relating to cooling tower drift. Heavy metals and salts listed under natural vegetation will be assayed.	Small (1/100 ac) permanent grid snap-trapping stations will be located in a representative number of the natural vegetation plots. Trapping will be done in October or November.	Twice during pre-operational phase, once per year for an undetermined number of years after the cooling towers becomes operational.	Evaluate before and after effects of nuclear plant cooling tower impacts.

Figure 6.2-1

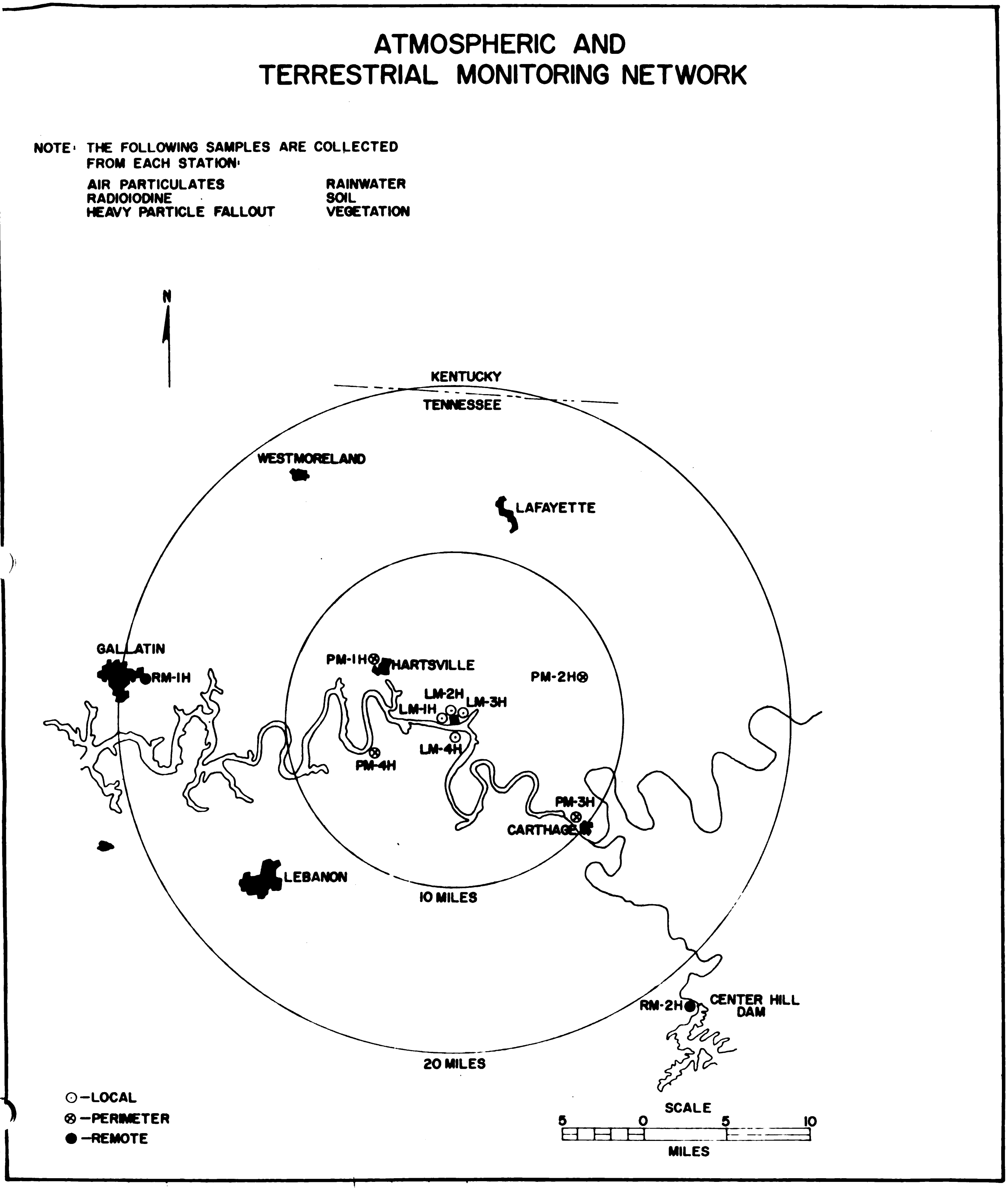
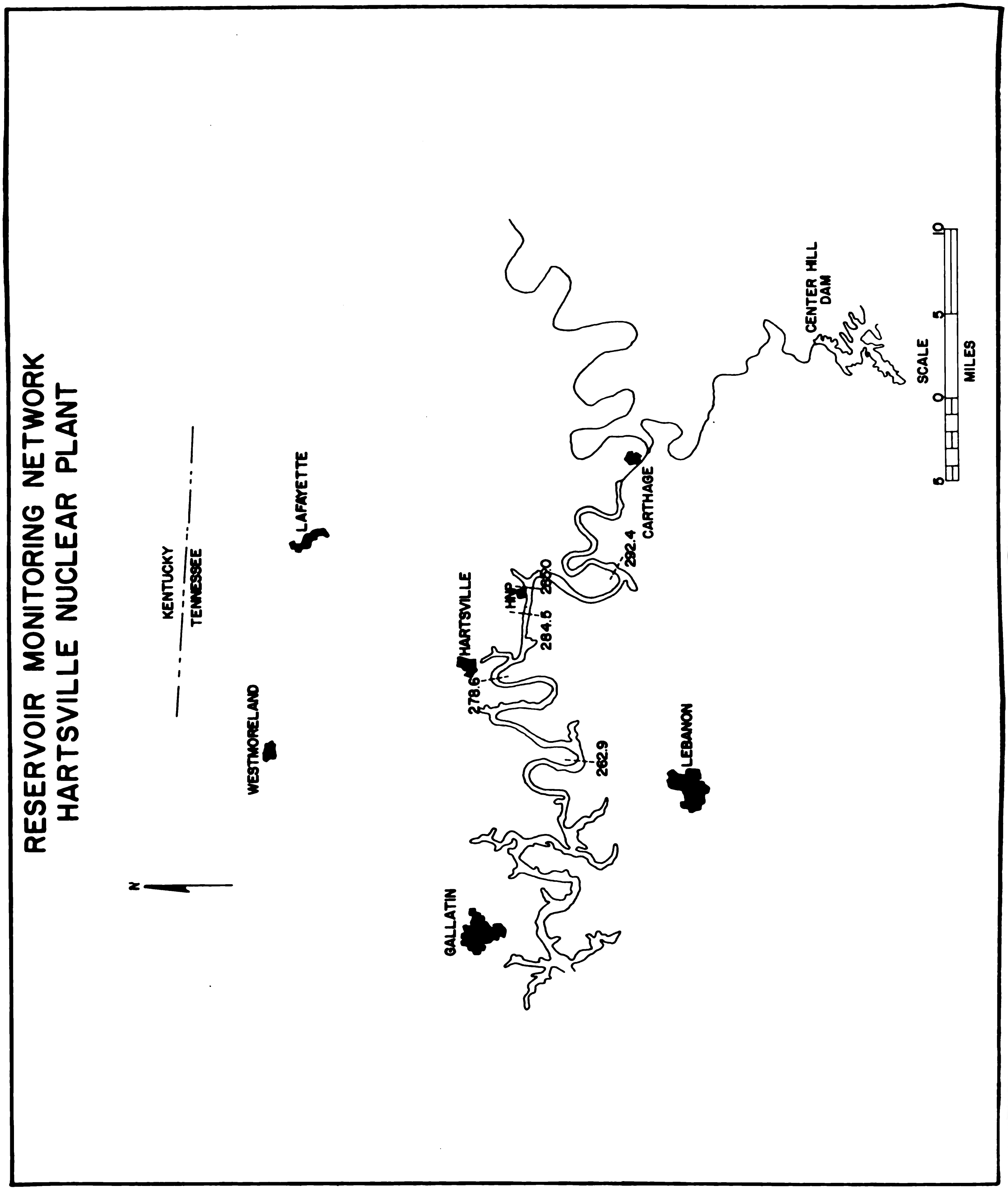

ATMOSPHERIC AND
TERRESTRIAL MONITORING NETWORK
NOTE: THE FOLLOWING SAMPLES ARE COLLECTED FROM EACH STATION:
AIR PARTICULATES
RADIOIODINE
HEAVY PARTICLE FALLOUT
RAINWATER
SOIL
VEGETATION
N
KENTUCKY
TENNESSEE
WESTMORELAND
LAFAYETTE
GALLATIN
RM-1H
PM-1H
HARTSVILLE
PM-2H
LM-2H
LM-1H
LM-3H
LM-4H
PM-4H
PM-3H
CARTHAGE
LEBANON
10 MILES
RM-2H
CENTER HILL DAM
20 MILES
⊙ -LOCAL
⊗ -PERIMETER
● -REMOTE
SCALE
5
0
5
10
MILES

Figure 6.2-2


RESERVOIR MONITORING NETWORK
HARTSVILLE NUCLEAR PLANT
KENTUCKY
TENNESSEE
LAFAYETTE
WESTMORELAND
HARTSVILLE
HNP
CARTHAGE
CENTER HILL DAM
LEBANON
GALLATIN
278.6
284.5
292.4
262.9
N
SCALE
5
0
5
10
MILES

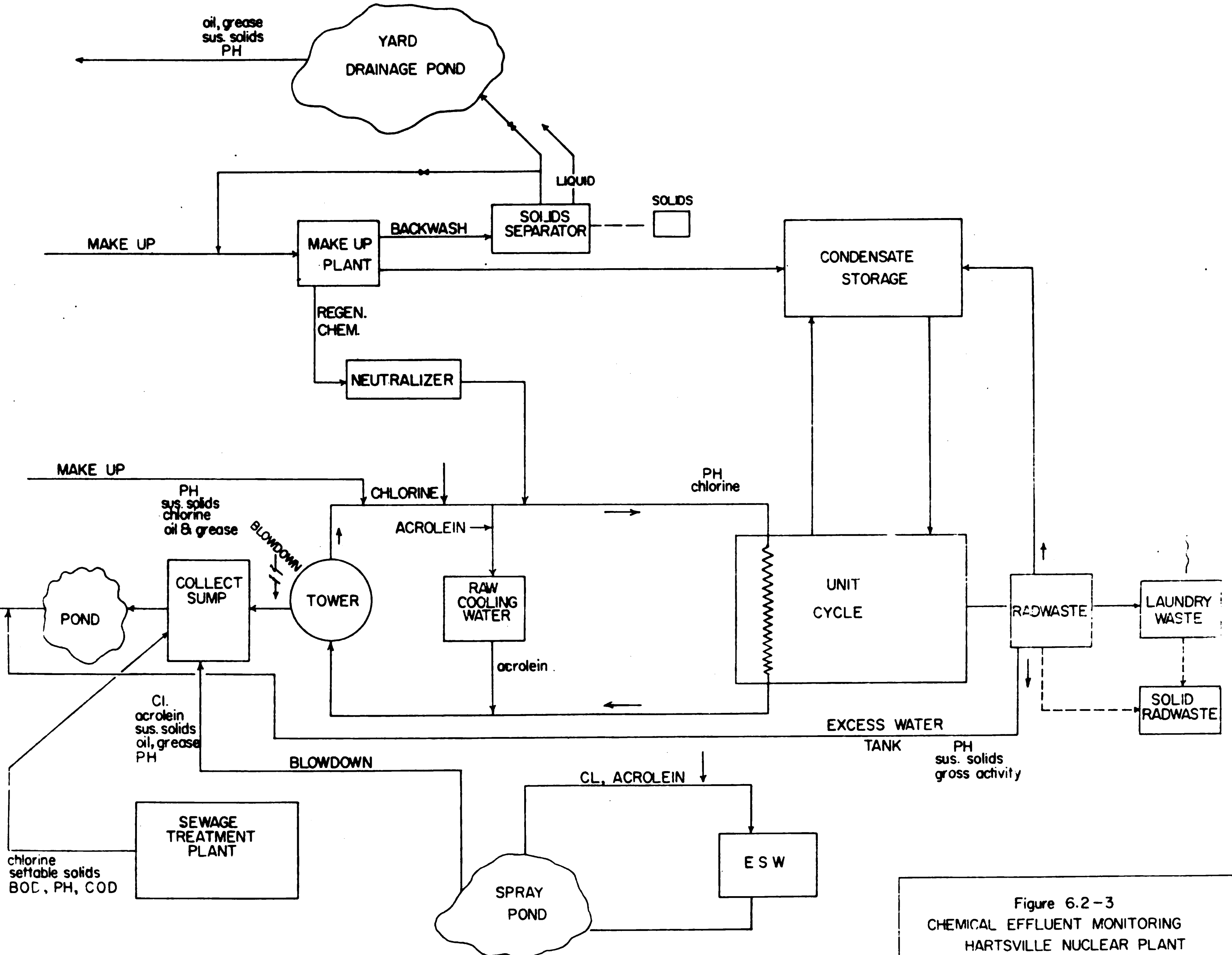


Figure 6.2-3
CHEMICAL EFFLUENT MONITORING
HARTSVILLE NUCLEAR PLANT

7.0 Environmental Effect

6.3

6.3 Related Environmental Measurement and Monitoring Programs

The Tennessee Division of Water Quality Control has routine chemical and biological monitoring stations at Cumberland River miles 308.25 and 207.0. With the exception of January, April, July and December, monthly grab samples are taken. Routine reports on water quality data from the Hartsville water plant are sent to the Tennessee Division of Sanitary Engineering.

Data are available from the U.S. Corps of Engineers on water quality characteristics of the water in the tailrace of Cordell Hull Dam.

Additional ecological information about the site is being collected by graduate students of Tennessee Technological University.

7.0 Environmental Effects Of Accidents

7.1

7.1 Plant Accidents Involving Radioactive Materials

A high degree of protection against the occurrence of postulated accidents in the Hartsville Nuclear Plant will be provided through correct design, manufacture, and operation, and the quality assurance program used to establish the necessary high integrity of the reactor system. Deviations that may occur will be handled by protective systems to place and hold the plant in a safe condition. Notwithstanding this, the conservative postulate is made that serious accidents might occur, even though they may be extremely unlikely, and engineered safety features will be installed to mitigate the consequences of those postulated events which are judged credible.

In the safety analysis report which TVA is submitting in accordance with AEC requirements, postulated accidents are evaluated using extremely conservative assumptions. This safety analysis shows that the calculated doses resulting from postulated accidents of great severity analyzed using highly conservative assumptions will be less than the 10 C.F.R. Part 100 requirements which ensure the public health and safety during accident conditions.

For the purposes of this environmental report, however, the probability of occurrence of accidents and the spectrum of their consequences to be considered from an environmental effects standpoint have been analyzed using best estimates of probabilities and realistic fission product release and transport assumptions. This approach to the analyses is therefore different from that used in safety analysis reports where conservative values are used to establish limits for design bases. The realistically

computed doses that would be received by the population are thus significantly less than those presented in the safety analysis.

As guidance for the estimation of realistically computed doses from postulated accidents from an environmental standpoint, the AEC issued Regulatory Guide 4.2 "Preparation of Environmental Reports for Nuclear Power Plants" dated March 2, 1973. TVA has based the analysis of accidents which is presented in this environmental report on the AEC guidance. Nine classes of postulated accidents and occurrences ranging in severity from trivial to very serious were identified by the AEC. In general, accidents in the high potential consequence end of the spectrum have a low occurrence rate and those on the low potential consequence end have a higher occurrence rate. The examples selected for these classes are shown in table 7.1-1. These examples are reasonably homogeneous in terms of probability within each class.

TVA's estimation of the doses which might be received by an assumed individual standing at the site boundary in the downwind direction, using the assumptions similar to those in Regulatory Guide 1.42, are presented in table 7.1-2. Estimates of the integrated exposure that might be delivered to the population within 50 miles of the site are also presented in table 7.1-2. The man-rem estimate was based on the projected population within 50 miles of the site for the year 2020.

Appendix H of the report, "Outline of Accident Analyses", describes in more detail the accidents analyzed including models, methods, and the more important assumptions.

The calculated doses are based on airborne transport of radioactive materials resulting in both a direct and an inhalation dose. It is expected that the environmental monitoring program and appropriate additional monitoring (which could be initiated subsequent to a release incident detected by in-plant monitoring) would detect the presence of any consequential amount of radioactivity in the environment in a timely manner such that remedial action could be taken if necessary to limit exposure via other potential pathways to man.

To rigorously establish a realistic annual risk, the calculated doses in table 7.1-2 would have to be multiplied by estimated probabilities. The events in Classes 1 and 2 represent occurrences which are anticipated during plant operations; their consequences, which are very small, are considered within the framework of routine effluents from the plant and are discussed in Sections 3.5 and 5.3. Except for a limited amount of fuel failures, the events in Classes 3 and 4 are not anticipated during plant operation; but events of this type could occur sometime during the 40-year plant lifetime. Accidents in Classes 6 and 7 and small accidents in Class 8 are of similar or lower probability than accidents in Classes 3 and 4, but they are still possible. The probability of occurrence of large Class 8 accidents is very small. Therefore, when the consequences indicated in table 7.1-2 are weighed by probabilities, the environmental risk is very low. The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protection systems and engineered safety features. Their consequences could be severe. However, the probability of their occurrence is judged so small that their environmental risk is extremely low.

Defense in depth (multiple physical barriers), quality assurance for design, manufacture and operation, continued surveillance and testing, and conservative design are all applied to provide and maintain a high degree of assurance that potential accidents in this class are, and will remain, sufficiently small in probability that the environmental risk is extremely low.

The AEC is currently performing a study to assess these risks more quantitatively. It is called the Reactor Safety Study and is an effort to develop realistic data on the probabilities and sequences of accidents in water-cooled power reactors. The results of this study were not yet available to TVA at the time of preparation of this report.

Table 7.1-2 indicates that the realistically estimated radiological consequences of the postulated accidents would result in exposures of an assumed individual at the site boundary to radiation doses that are within the limits of 10 C.F.R. Part 20. The table also shows for each postulated accident the estimated integrated exposure of the population within 50 miles of the plant. When considered with the probability of occurrence, the annual potential radiation exposure of the population from each postulated accident is only a fraction of the annual exposure from natural background radiation. It is concluded from the results of the realistic analysis that the environmental risks due to postulated radiological accidents are exceedingly small.

Table 7.1-1

Classification of Postulated Accidents and Occurrences

Class	General Description	Specific Accidents and Occurrences Analyzed
1	Trivial incidents	Spills and leaks inside containment
2	Small releases outside containment	Spills, leaks, and pipe breaks outside containment
3	Radioactive waste system failure	1. Equipment leakage or malfunction (includes operator error) 2. Release of waste gas storage tank contents 3. Release of liquid waste storage tank contents
4	Release of fission products to primary system (BWR)	1. Fuel cladding defects 2. Off-design transients that induce fuel failures above those expected
5	Fission products released to primary and secondary systems (PWR)	This class of accidents is not applicable to the Hartsville Nuclear Plant because it is a BWR
6	Refueling Accidents	1. Fuel bundle drop 2. Heavy object drop onto fuel in core
7	Spent fuel handling accidents	1. Fuel assembly drop in fuel storage pool 2. Heavy object drop onto fuel rack 3. Fuel cask drop
8	Accident initiation events considered in design basis evaluation in safety analysis report	1. Loss of coolant accidents (a) small pipe break (b) large pipe break (c) instrument line break 2. (a) control rod ejection accident (PWR). This accident is not applicable to Hartsville Nuclear Plant because it is a BWR (b) control rod drop accident (BWR) 3. (a) Steamline breaks (PWR) - This accident is not applicable to Hartsville Nuclear Plant because it is a BWR (b) Steamline breaks (BWR) - (1) small pipe break (2) large pipe break

Table 7.1-1 (continued)

9	Hypothetical sequence of failures more severe than Class 8	Accidents of Class 9 are so improbable that they are not considered in this analysis

Table 7.1-2

SUMMARY OF RADIOLOGICAL CONSEQUENCES OF POSTULATED ACCIDENTS

Classification of Event	Description of Event	Est. Fraction of 10 C.F.R. Part 20 Limit at Site Boundary	Est. Dose to Population in 50-mile Radius, Man-rem
1	Trivial incidents	*	*
2	Small release outside containment	*	*
3.1	Radioactive waste leakage or malfunction	6.1×10^{-4}	5.3
3.2	Release of waste gas storage tank contents	5.4×10^{-3}	4.5×10^{1}
3.3	Release of liquid storage tank contents	6.4×10^{-2}	5.9×10^{2}
4.1	Fuel cladding defects	*	*
4.2	Off-design transients	1.5×10^{-2}	1.1×10^{2}
5	Releases to primary and secondary systems (PWR)	NA	NA
6.1	Fuel bundle drop	4.2×10^{-4}	3.6
6.2	Heavy object drop onto fuel in core	4.6×10^{-3}	4.1×10^{1}
7.1	Fuel assembly drop in fuel storage pool	4.2×10^{-4}	3.6
7.2	Heavy object drop onto fuel rack	2.6×10^{-4}	2.2
7.3	Fuel cask drop[a]	5.2×10^{-3}	4.3×10^{-1}
8.1(1)	Small pipe break	1.9×10^{-6}	1.3×10^{-2}
8.1(2)	Large pipe break	7.7×10^{-2}	4.8×10^{2}
8.1(a)	Instrument line break	NA	NA
8.2(a)	Control rod ejection accident (PWR)	NA	NA
8.2(b)	Control rod drop accident	1.9×10^{-2}	1.4×10^{2}
8.3(a)	Steamline break (PWR)	NA	NA
8.3(b)(1)	Small steamline break (BWR)	2.0×10^{-4}	1.8
8.3(b)(2)	Large steamline break (BWR)	1.2×10^{-2}	1.1×10^{2}

*Evaluated as routine release in Section 5.3, Radiological Impact on Man

NA - Not applicable

a. Based on one fuel assembly per cask

**Based on gamma and beta external doses plus iodine inhalation doses; actual doses to the whole body or any organ would be less.

7.2

7.2

7.3

7.2 Accidents During Transportation

7.2.1 New Fuel - The problems which might result from a transportation accident equivalent to that specified in 10 CFR Part 71 would consist of the physical damage of the impact and the interference and delay associated with having to send the fuel back to the fabricator for inspection. A subsequent determination would then be made to determine whether there had been damage which would affect the operation of the fuel in the reactor. There would be no release of radioactive materials and no increase in radiation dose rates over those from normal shipment. Thus, it is concluded that there would be no significant environmental risks from radiation resulting from an accident involving a shipment of new fuel.

7.2.2 Spent Fuel - The principal potential environmental effects resulting from an accident involving spent fuel shipment would be the radiation doses resulting from the increased radiation levels, from the gaseous release of iodine and noble gases, and from the release of contaminated coolant. The dose from direct radiation was calculated using AEC assumptions [1,2]. Evaluation of exposure from direct radiation assumes that the radiation exposure rate is the maximum permitted by regulations, 1,000 mrem/h at 3 feet from the surface of the container, and that people have surrounded the container beginning at about 50 feet from the container.[1] Figure D-3 of Appendix D shows the exposure rate for accident conditions as a function of distance from the container. The exposure rate at 50 feet would be about 17 mrem/h. Assuming a tightly packed crowd, the people in the front row would provide shielding such that people in subsequent rows would receive greatly reduced radiation exposure.

If a person remained in the front row for 2 hours, his exposure would be about 34 mrem. Further, the increased radiation level would most likely be from only a localized area on the container, and thus only a small number of people in even the front row of a crowd would be exposed to these radiation levels. The method of calculation is discussed in Appendix D.

Because of the dose reduction with distance and the mitigating effect of proposed emergency actions, it can be concluded that the whole-body radiation exposure to the public would be negligible.

Calculations for a probable shipping container indicate that there would be no gaseous releases unless there were a substantial quantity of decay heat in the shipping container and some additional external heat such as from a fire. Appendix E contains a discussion of the Type "B" containers which will be used for spent fuel shipment and lists the standards this packaging must meet. It is believed that due to the unlikely combination of circumstances which must be present the probability of having an accident resulting in the release of noble gas and iodine is about 8×10^{-3} per million miles traveled.[2] Based on this and a conservatively assumed mileage for spent fuel shipment, it is projected that the probability that an accident of this nature would occur during the plant life is about .045. For overweight shipments by truck or shipments by rail, this probability would be much less. Despite this low probability of occurrence, potential doses resulting from such an accident have been calculated.

It is assumed that the heated air currents surrounding the container would carry any released fission gases to a height of 10 meters before they are dispersed in the environment. Assuming a person stands in the plume during the entire accident, the resulting whole-body exposure would be 2 mrem, the skin dose would be about 86 mrem, and the thyroid dose would be about 5 rem. For the noble gas release, based on an average population density of 100 people per square mile, the total whole-body population dose from the accident would be 0.07 man-rem. The method used is given in Appendix D.

When the doses which have been calculated are considered along with the low probability of occurrence of the set of circumstances which would result in these doses, it is felt that the environmental risk is extremely small.

<u>7.2.3 Radioactive Waste</u> - All radioactive wastes which will be shipped from the plant will be much lower in levels of radiation and in concentration of radioactive material than the spent fuel previously discussed. The type of packaging used will depend upon the type of waste and its activity level and will comply with AEC and Department of Transportation regulations.

A discussion of Type A and B packaging is given in Appendix E. These packages are designed and constructed in such a manner that in the unlikely event of an accident there is a very low probability that the radioactive material would be released.

Soft solid wastes such as paper, contaminated clothing, and rags compacted and placed in drums are typical Type A packages of solid

waste. Each may contain as much as 1 curie of activation and fission products, primarily Fe-59 and Cs-137 distributed throughout about 500 pounds of waste.[2]

The casks which will be used to haul cleanup sludge, spent resins, filter sludge and concentrated wastes will, as a minimum, be qualified Type B packages licensed by AEC. The expected activity per package will be well below that discussed in WASH-1238 for a 55-gallon drum and the cask will be of better construction than the 55 gallon drum. Even if the material were released, most of the radioactivity is tightly bound in the solid waste and there is no ready dispersal mechanism.

The probability of an accident involving a shipment of radwaste is small. The package design and construction coupled with the radioactivity levels and form of the waste make a release in the event of an accident unlikely. In the unlikely event some release does occur, the small amount of radioactivity and the fact that it is bound in a solid form combine to make the probability of serious radiation doses quite small. For the above reasons, TVA considers that the environmental risk from the transportation of solid radioactive waste is small.

References for Section 7.2

1. General Packaging and Shipment Requirements, Department of Transportation Regulations (49 C.F.R.), Regulations Section 173.393.

2. Environmental Survey of Transportation of Radioactive Materials To and From Nuclear Power Plants, USAEC Report, WASH-1238, December 1972.

7.3

7.3 Accidents Involving Nonradioactive Materials

Oils, chemicals, and other materials will be transported to and from the proposed plant and will be stored on site in various areas. The accidental release of these to the environment could cause adverse effects. Evaluation of the probability and effects of accidents which could cause such releases are included below.

The probability of accidental releases from any cause will be minimized by proper design of storage and handling facilities, operator surveillance, attendance of personnel during operations, and written instructions. TVA is presently preparing a general "Oil and Hazardous Materials Contingency Plan" for all TVA facilities as required by both Executive Order and Federal legislation. As part of this plan a separate "Spill Prevention, Control, and Countermeasure Plan" will be prepared for each individual facility, including the Hartsville Nuclear Plant. The storage of hazardous liquids at the plant will be kept to a minimum consistent with maintaining plant reliability.

It is concluded that the use of multiple storage tanks and collection sumps and the use of retention basins and limestone beds reduces the risks to the environment associated with storage of potentially hazardous materials to the minimum practicable level.

7.3.1 Oil Spills - Oil will be used in various equipment and stored in storage tanks both inside and outside the powerhouse. The tanks will be located in basins and diked areas which are designed with a volume larger than the volume of the tank located in the area. This design is such that leakage, spillage, or ruptures from any cause will not result in release of stored materials to Old Hickory Reservoir.

In the event of a tank or equipment rupture resulting from plant malfunction, human error, or natural disasters such as tornadoes, earthquakes, etc., oil in any of the outside equipment or storage tanks will be contained in retention basins unless the occurrence were of a severity to destroy the basins. The probability of an occurrence of this severity is very low. Consequently, the environmental risk associated with the storage of these materials is very small.

Oils spilled in the plant buildings will flow to appropriate sumps where they are retained until they can be reclaimed. If not suitable for reuse, they will be drummed for proper disposal. One method of disposal is to transport the oil to one of TVA's fossil-fired plants and blend it with the fossil fuel used there.

Oil will be shipped to and from the plant site under applicable ICC and DOT regulations to minimize environmental risks.

7.3.2 Chemical Spills - Indoor storage will be provided for the sodium hydroxide which is used in the makeup water treatment plant as well as other chemicals such as ammonia and hydrazine used for auxiliary steam generator water treatment. Chemicals stored in tanks onsite are provided with retention basins and/or crushed limestone beds to either contain or neutralize these chemicals if they should be released from their storage tanks.

Chemicals spilled in the powerhouse will flow to sumps where they will be retained until pumped either to appropriate containers for disposal or to the radwaste building where facilities for filtering, settling, and other types of treatment are installed to assure that no harmful substance is released to surface watercourses.

Arrangements will be made to retain stored hazardous chemicals in case of spillage. For sulfuric acid and sodium hydroxide, separate retaining pits will be provided to hold the entire stored volume of each chemical while steps are taken to containerize the spilled liquid or otherwise dispose of it in a safe controlled manner. For ammonia and hydrazine, a pit will be provided to hold the volume of the largest storage tank.

Outside storage will be provided for the sulfuric acid which will be used in the makeup water treatment plant. The storage tank will be located within a diked area to contain any spill. Crushed limestone will be used to neutralize any spillages.

Liquid nitrogen for use in inerting the primary containment vessels is stored in an outdoor insulated tank. Rupture of the tank would result in spilling the liquid nitrogen onto a limestone bed. The liquid would soon vaporize, producing no adverse effect on the environment.

All potentially harmful chemicals and other materials will be shipped to Hartsville by rail or by truck under applicable ICC and state highway regulations.